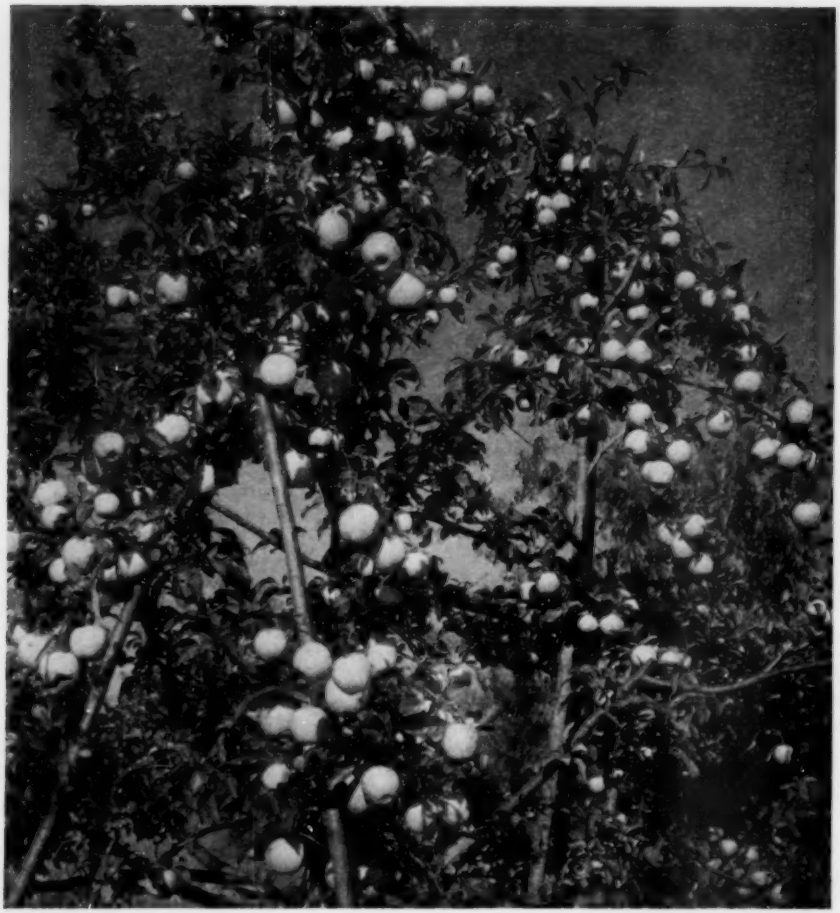
Diseases and Insects in the Orchard

By W. D. MILLS and A. A. LAPLANTE



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LIST OF DISEASES AND INSECTS, AND SPRAY OUTLINES

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Diseases and Insects in the Orchard

W. D. Mills and A. A. LaPlante

The important facts concerning the life histories and the practical control of orchard diseases and insects by spraying and dusting under New York conditions are given in this bulletin. Spray schedules are based on the latest published and unpublished data of the research workers of the state experiment stations, and the authors' observations of practices followed by successful fruit growers are given. It has been prepared after conferences with the members of the experiment stations at Geneva and Ithaca.

APPLES

The most important problems are **apple scab, codling moth, apple maggot, plum curculio, red-banded leaf roller, orchard mites,** and **aphids.** Occasionally, **cedar rusts** are of major importance either locally or generally throughout the region. Other diseases and insects are restricted in importance to more or less definite areas. Because of these variations in importance of the different insects and diseases with locality and year, the following schedule must be considered as a general outline of the spray program to be modified to meet the actual conditions in the orchards to be treated. In counties where the Extension Service conducts a spray-information service, valuable assistance in adapting the general recommendations to individual needs may be obtained on request.

SPRAY OUTLINE

FALL AND WINTER APPLICATIONS

Fall and winter sprays of DNC[1] materials are as effective as the use of those products in the spring for the control of **rosy apple aphid** and **eye-spotted bud moth.** To control rosy aphid with fall applications of these materials, you need 1½ quarts of the liquid or 1½ pounds of the powder form to make 100 gallons of spray. For control of bud moth, you need the following; 3 quarts of liquid or 3 pounds of powder in each 100 gallons of water for light to moderate infestations and 4 quarts and 4 pounds respectively for heavy infestations. For best results and for maximum safety to the trees, the sprays are best applied after the leaves have dropped.

Do not make fall applications until either most of the leaves have fallen from the trees or temperatures of 20°F. or below have been experienced. Observations indicate that egg-laying does not cease until these conditions are met. It has not been fully proved whether fall applications will effectively control oystershell scale, but they may be tried in light infestations.

DNBP[2] materials (Elgetol 318, DN 289) are not recommended for fall applications. They are more injurious than the DN materials previously used. Experience indicates that injury may result if fall applications are made.

You may spray any time during the winter when temperatures are above freezing and the spray is permitted to dry without freezing. Oil sprays, however, should not be applied until March or April since injury may result.

[1]DNC contains dinitro ortho cresol. Sold in liquid and powder form in New York State as Elgetol, Krenite, DN Dry Mix No. 2, Dinitro Dry, Ortazol Powder, and the like.

[2]DNBP contains dinitro secondary butyl phenol.

SPRING APPLICATIONS

Dormant spray

(After the buds have begun to swell but before they show green at the tip)

When control measures are necessary for **rosy, green,** or **apple** aphids, **oystershell scale,** or **bud moth,** the DN, or dinitro, spray materials are recommended.

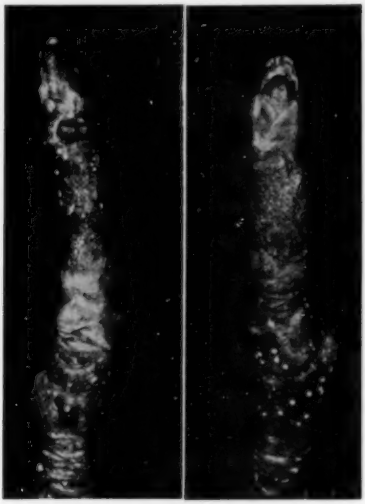


FIGURE 1. PROPER STAGE TO APPLY DORMANT SPRAY

The recommended quantities for DNC materials in each 100 gallons of spray are as follows:

Aphids require 1½ quarts or pounds for effective control.

Bud moth and oystershell scale require from 3 to 4 quarts or pounds for effective control.

DNC compounds when combined with petroleum oil have caused severe injury in some orchards. It is therefore suggested that the oil be applied separately either after a heavy rain has washed most of the water-soluble DNC from the trees or better still in a green-tip to delayed-dormant spray.

The newer dinitro materials (DNBP) are equally as effective as the older DN materials against aphids, bud moth, and scale insects. These materials are known to growers as DN–289 and Elgetol 318. In addition to being effective against pests controlled by the DNC materials they are also effective against **scurfy scale** and **San José scale** and are effective at lower concentrations than regular dinitros. Likewise they may cause serious injury to buds **if used later than the dormant stage** of bud development. Concentrations should be used as follows:

Aphids .....1 quart in 100 gallons
Bud moth .....2 quarts in 100 gallons
*Scale insects .....2 quarts in 100 gallons

*Oystershell scale requires from 3 to 4 quarts.

DNBP materials are also toxic to many of the overwintering eggs of the European red mite. Experience has shown, however, that mite populations built up more rapidly during the summer with DNBP materials as compared with applications of dormant oil. DNBP materials are therefore not recommended as a dormant control for overwintering eggs of the European red mite. Where European red mite populations have been high the past summer or where a heavy deposit of overwintering eggs is present in the orchard, it is suggested that oil be used preferably in the green-tip or delayed-dormant application as an early red-mite control measure.

It has been the custom to omit aphicides on non-rosy-aphid susceptible varieties, such as McIntosh, Duchess, and Wealthy. There is some evidence, however, to show that green-aphid control in the summer is made considerably more difficult by this omission. It is therefore advisable to spray all varieties for aphids.

Semi-dormant sprays (silver tip, green tip, and delayed dormant)

Silver-tip stage

(When the blossom buds begin to swell showing silvery tips)

The first danger of apple-scab infection is on the sepals when the fruit buds are in the silver-tip stage. Sepal infection occasionally occurs in western New York and was general in that area in 1951. Sepal infection is rarer in the Hudson Valley. There were, however, small amounts in the southern end of the Hudson Valley in 1952, and in 1953 it was considerably more abundant.

The development of the apple-scab fungus is closely followed in both areas, and the growers are notified if scab spores are mature and if silver-tip or early green-tip infection is possible. Under such circumstances an additional early application of fungicide may be required for scab control in addition to the bordeaux mixture commonly applied in the green-tip or delayed-dormant stage.

FIGURE 2. PROPER STAGE TO APPLY GREEN-TIP SPRAY

Green-tip stage

(When the blossom buds are bursting and show from 1/8 to 1/4 inch of green color)

and

Delayed-dormant stage

(When the leaves of blossom buds are out from 1/4 to 1/2 inch)

The most important disease to control through this period is **apple scab.** The control of such insects as **European red mite, fruit-tree leaf roller, red bug, scurfy scale,** and **San José scale** may also be obtained at this time with dormant superior oil. Under present-day conditions, however, in New York State fungicide and oil are used principally to control **scab** and **red mite.**

Bordeaux mixture	2–4–100
"Superior" type oil	2 gallons
Blood albumin (actual)..	2 ounces
Water to make	100 gallons

FIGURE 3. PROPER STAGE TO APPLY DELAYED-DORMANT SPRAY

Best results have been obtained by emulsifying oil sprays in the spray tank. A suitable emulsifier is blood albumin used at the rate of 2 ounces of actual blood albumin to 100 gallons of the spray mixture. Only the blood albumin that is soluble in water should be used. Those that form only a temporary suspension and settle to the bottom after being shaken vigorously in a container of water are unsatisfactory. Suitable commercial brands that contain 2 ounces of actual blood albumin in ½ pound of finished product are available.

Bordeaux mixture is usually added for protection against early scab infection. It is preferable to emulsify the oil with blood albumin and then to add the 2 pounds of powdered copper sulfate and 4 pounds of lime to form the bordeaux mixture rather than to emulsify the oil with the bordeaux mixture.

More than one spray may be required during this period for **apple scab** control. The above formula containing oil and bordeaux mixture should, however, be used only once. It has been shown that **European red mite** control is effective at any time during the green-tip or delayed-dormant period and it is therefore merely a convenience to use the bordeaux-oil formula. Where oil is not used, in other words where additional **scab** treatments are required, one of the following may be applied:

Lime-sulfur .....2 gallons
or
Elemental sulfur at manufacturers' directions
Water to make .....100 gallons

If a **San José scale** problem exists, the 2 gallons of oil in the bordeaux-oil formula will be enough. If **scurfy scale** is a problem, 3 gallons of oil are needed.

The use of superior oil during this period of tree development is at present considered the most practical control measure against over-wintering **European red mite,** because the excessive use of any one insecticide in summer treatments may develop populations of mites resistant to that insecticide.

If a DN spray was omitted or could not be applied for aphid control, BHC may be used at the rate of 2 pounds of a 10 per cent gamma isomer powder or the equivalent in other strengths, or lindane at 1 pound of the 25 per cent powder, in the bordeaux-oil formula. Best results are obtained at the full delayed-dormant stage; but to prevent injury from the bordeaux-oil formula, spraying should be completed before the leaves roll back and expose the blossom buds. This spray is not so efficient as a dormant DN spray for aphids and is ineffective against **bud moth.** Malathion shows promise in a combined aphid and bud-moth control. It might be used on a trial basis at the rate of 2½ pounds of the 25 per cent wettable powder. Parathion may be used for this purpose in extreme emergency, at the rate of 1 pound of 15 per cent wettable powder, but it is felt that the importance of scab control at this time does not warrant its use. If a ferbam-oil mixture is used rather than a bordeaux-oil mixture, TEPP may be used for aphid control alone. None of these materials controls oyster-shell scale.

In New York State tests, ovotran (also known as orthotran) shows promise as a substitute program for superior oil. Some growers may wish to use, on a trial basis, this material at the rate of ¼ pound in the pink spray, and ½ pound in the special curculio-scab spray, the second cover, and the fourth cover. This program also has some value against early two-spotted and four-spotted mites.

Pre-blossom sprays

Elemental sulfur at manufacturers' directions
or
Lime-sulfur ..... 2 gallons
Water to make ..... 100 gallons

The pre-blossom spray or sprays, applied between the delayed-dormant spray

and bloom, are timed primarily for **scab** control. The points to be considered in timing the applications are: the occurrence of rain periods, the amount of new growth, and the stage of development of the scab fungus. In some seasons, two or more pre-blossom applications may be required for effective **scab** control, especially on extremely susceptible varieties such as McIntosh.

FIGURE 4. PRE-BLOSSOM, EARLIEST STAGE WHEN ONLY ONE SPRAY IS APPLIED

Dusting or spraying with elemental sulfurs during rain may be a valuable aid in **scab** control. Both are effective if properly applied. The paste sulfurs are especially valuable for sprays during rain, but the dry wettable sulfurs may also be used. The addition of 1 pound of hydrated lime increases the effectiveness of both forms. An oil type of sticker increases the deposit of sulfur during a rain, but the paste sulfurs give excellent control at from 10 to 12 pounds in 100 gallons of spray without a sticker. Sulfur dusts are effective also during rain, but usually an application must be repeated for protection through the next rain. The finest divided dusts are most effective and the addition of wetters or stickers to the dusts has not been shown to increase effectiveness. The effective use of these materials during rain is discussed in Cornell Extension Bulletin 630, *Efficient Use of Sulfur Dusts and Sprays during Rain to Control Apple Scab.*

The phenyl mercury compounds (Tag and Puratized) and the napthoquinone compound (Phygon) may also be used in rain or after rain (page 24). Lime-sulfur is an excellent protectant and a good after-rain treatment but should not be applied on wet foliage during bloom or during or preceding very high temperatures (page 24). Mercury sprays are also dangerous at those times. In past years, the mercury sprays in bloom had apparently caused no injury to foliage, fruit set, or to bees. In 1953, however, serious reduction in set followed bloom sprays of mercury.

Ferbam is safe on apple foliage but has caused considerable enlargement of fruit lenticels and some russeting. Ferbam also showed some after-rain control of scab in 1953 but cannot be relied upon for this purpose (page 23).

On red and Golden Delicious, captan (Captan 50W and Orthocide 406) has usually given higher finish than any other fungicide for the past three years. The use

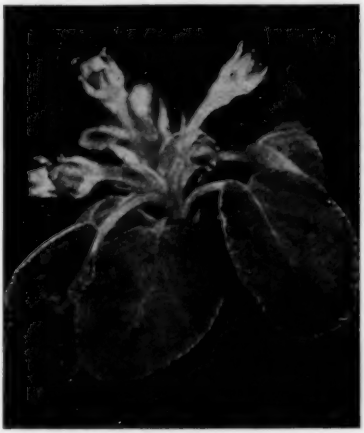


FIGURE 5. PRE-BLOSSOM, IDEAL STAGE TO SPRAY IF WEATHER PERMITS

of methoxychlor in the curculio sprays and DDT in the cover sprays along with a captan program appears to be the most promising combination on these varieties (page 25).

Glyodin (Crag 341) was an effective protectant against apple scab, at 1 quart per 100 gallons during primary scab, and from 1 to 1½ pints later. 341 should not be used on apples in New York State at the rate of more than 1 quart per 100 gallons. The mixture of 1 pint of glyodin (341) with half strength mercury has given excellent control when combined protection and after-rain control were needed (page 24).

For eradication of leaf scab, DN Dry-Mix No. 2, (½-100), with lime, (3-100) and a spreader gave as good results in 1953 as in 1952, when thoroughly applied before the lesions began to cork off. Two applications may be necessary, depending upon the stage of scab development and overlapping infection periods. This mixture is probably safest when used with a wettable sulfur. It is ineffective with Crag 341. Do not apply it during hot weather (more than 75° F.) or if hot weather is likely to follow. DN Dry-Mix No. 2[2] is safer to use after bloom than before. There is little information on what might be expected on varieties other than McIntosh.

If chewing insects, such as **fruit tree leaf roller, green fruitworms, tent caterpillars, cankerworms,** present a serious threat to the foliage or buds, 2 pounds of 50 per cent wettable DDT powder may be included in the pre-blossom spray. Generally, unless the threat is serious, it is advisable to postpone the use of DDT until petal-fall spray to reduce possible danger to pollinating insects. *Lead arsenate should not be used in this spray* because it poisons pollinating insects. If an insecticide is to be used in this spray, honeybees must be removed from the neighborhood.

[2]DN No. 2 = 40 per cent dinitro-o-cresol.

Special bloom spray

*(When three-fourths of the blooms are open in orchards where **fire blight** is a problem)*

Copper sulfate	2 pounds
Hydrated lime	6 pounds
Water to make	100 gallons

or

20–80 copper-lime dust

One application is usually made when three-fourths of the blooms are open but, if the disease has been very severe, an additional early application may be made when about one-fifth of the blossoms are open. The possibility of a reduction of the set of fruit and of fruit russeting by applications of copper during bloom should be balanced against the likelihood of blossom infection in deciding whether to apply the material in individual orchards.

The phenyl mercury sprays have been used in earlier limited tests in New York with some control of blight and with no apparent reduction of fruit set. With a reduction in set up to 50 per cent, which occurred in 1953 with mercury sprays in bloom, bloom sprays of mercury in 1954 are not suggested.

Dithane Z-78, at 2 pounds per 100 gallons, has been reported favorably for fire-blight control in bloom sprays in several States. In limited New York experiments there has been no blight to test its efficiency.

Certain antibiotics appear extremely effective in fire-blight control and may replace present materials if the antibiotics can be made available at a reasonable cost (page 53).

The spray application is supplementary to such measures as chemical treatment or cutting out of cankers, pruning out blighted branches and suckers, and breaking off blighted fruit-spurs.

Ferbam has been shown in Hudson Valley experiments to be much more efficient than sulfur in the control of **cedar rusts.**

Where the rusts are serious in the Hudson Valley, ½ pound of this organic compound, with 3 pounds of elemental sulfur in 100 gallons of spray, is suggested for the pre-bloom spray, in a bloom spray, and in the petal-fall and curculio sprays (pages 41 and 42).

In orchards that received the pre-blossom spray some time in advance of the opening of the blossoms or where the pre-blossom spray was omitted, or in seasons when the bloom period is unusually long and rainy, bloom applications of elemental sulfur may be valuable aids in scab control. Yield, however, may be reduced by these bloom applications, and their use is justified only when the amount of bloom and pollinating conditions are adequate and a disease problem exists. *Insecticides should not be included in any bloom application.*

Petal-fall spray

(When the last of the petals are falling)

Before you apply a petal-fall spray, remove honeybees from the orchard and place them at least one mile away.

Lime-sulfur	2 gallons
or	
Elemental sulfur (actual sulfur)	5 pounds
Lead arsenate	3 pounds
Hydrated lime	3 pounds
Water to make	100 gallons

Other fungicides which may be used in place of sulfur in the schedule above are captan 2 pounds, ferbam 1½ pounds, and glyodin 1 quart. These organic fungicides are discussed on pages 23 to 25.

The lead arsenate formula often gives adequate protection against **plum curculio** in most western New York orchards except for early varieties, such as Duchess. The hydrated lime is included as a protection against arsenical injury but may be omitted where ferbam fungicides are used. If the dormant oil is omitted, 2 pounds of DDT may be included where **scurfy scale, oystershell scale, San José**

FIGURE 6. PROPER STAGE TO APPLY PETAL-FALL SPRAY

scale, fruit-tree leafroller or **red bug** are of importance, and the concentration of lead arsenate and lime may be dropped to 2 pounds of each. The combination of DDT and lead arsenate affords more protection against plum curculio than does lead arsenate alone. Both lead arsenate alone and the combination of lead arsenate and DDT are of little value against **red-banded leaf roller** in seasons of severe first-brood attack, such as 1951, and should be bolstered with DDD (also called *TDE)* in either the petal-fall spray or the curculio spray at the rate of 1 pound of 50 per cent powder.

The use of parathion on non-McIntosh varieties at the rate of 2 pounds of 15 per cent powder in 100 gallons of spray mixture when used in the petal-fall and the curculio sprays in both eastern and western New York and in the first cover spray in eastern New York gives protection in many orchards against **plum curculio, red banded leaf roller** and, **European red**

mite. Other pests controlled in these sprays are **red bug, fruit-tree leaf roller, tarnished plant bug,** and **oystershell scale.** If parathion is used, an aphicide will be required in the dormant or delayed dormant sprays and further insecticidal treatments should not be necessary until the petal-fall spray, provided resistance to parathion by the **European red mite** is not a problem. If resistance is a problem, the oil spray is suggested in addition. Its use on McIntosh variety and its relatives is referred to in the note on page 94.

In a cooperative experiment in New York in 1952 under conditions favorable for apple-scab infection, the use of parathion allowed significantly more scab to develop in combination with seven fungicides than where parathion was not used. Similar increases in scab with parathion have been reported from West Virginia, Virginia, and Michigan. It is not certain at this time whether the increases in scab and reduction in fruit set under New York conditions will be serious (page 94).

Where control of plum curculio alone is desired either methoxychlor at the rate of 3 pounds of the 50 per cent wettable powder or dieldrin at the rate of ½ pound of the 50 per cent powder, may be substituted for the lead arsenate in the formula. Both of these materials are much more efficient for this purpose than lead arsenate in heavy infestations. It is necessary to add DDD for red-banded leaf roller control, and in the Hudson Valley area DDT should be added to the dieldrin in the first cover spray for protection against the codling moth. Methoxychlor is safer than DDT to warm-blooded animals, but persons using dieldrin should follow the same precautions for safety recommended for the phosphorous-containing insecticides such as TEPP, parathion, and EPN.

To control European apple sawfly in the Hudson Valley area, either parathion or BHC is recommended. A thorough application at petal fall is usually enough. BHC at the rate of 2 pounds of 10 per cent powder may be added to other materials, such as lead arsenate, lead-DDT mixture, methoxychlor, or dieldrin. Parathion may be used alone or with activated carbon. It will probably be necessary to add fungicide to any of the above.

If wet weather prevails during bloom and if **scab** control is doubtful, or if scab spots are present on the leaves, lime-sulfur may be used. With dry weather during bloom and no scab present, elemental sulfur or one of the organic fungicides listed, is preferred for the petal-fall spray to lessen the danger of spray injury and of reduction in yield by lime-sulfur.

If conditions are favorable for a heavy infection of **scab,** one should spray as much as possible and use dust as a supplementary measure.

Curculio or special scab spray

(From 1 to 2 weeks after the petal-fall spray)

325 mesh sulfur	5 pounds
or	
Organic fungicides at manufacturers' directions	
Lead arsenate	3 pounds
DDD	1 pound
Hydrated lime	3 pounds
Water to make	100 gallons

In New York this spray is normally the most important single spray for **plum curculio** but it is equally important for the control of **apple scab.**

The spray is timed from 7 to 10 days after petal fall in eastern New York, primarily for plum curculio. The choice of the interval is based upon the temperature at that time and to some extent on rainfall and fruit growth. Temperatures of more than 75° F. for several successive days after the fruit has formed are most favorable for curculio attack. If the fruit is well covered prior to a warm period, control should be excellent. If very cool weather prevails, the longer interval would

be the more practical. Excessive rainfall will smooth out a spray deposit, thus making it insecticidally less efficient, and a very rapid fruit growth will reduce the deposit. Under either of these conditions, the shorter interval would be desirable.

The lead arsenate and DDD (TDE) formula should be used in areas or orchards where plum curculio is not a serious threat. Hydrated lime is a corrective for arsenical injury but should be omitted where ferbam or captan fungicides are used.

The DDD (TDE) is needed to control **red-banded leaf roller** if not already used in the petal-fall spray. The spray should be directed to the undersides of the leaves. Some advantage in curculio control may be gained by adding 2 pounds of DDT to the formula and reducing the lead arsenate to 2 pounds. It is felt, however, that where the curculio problem is serious enough to require an additional insecticide, it would be more advisable to use either parathion, methoxychlor or dieldrin rather than the mixture of lead arsenate and DDT.

The discussion under petal-fall spray concerning parathion, methoxychlor and dieldrin (page 12) applies here. The most practical schedule for insect and mite control is the use of parathion at the rate of 2 pounds in 100 gallons of spray mixtures. Details concerning use of this material on McIntosh and its relatives are given on page 94.

In western New York orchards in many seasons, a special spray, applied about 2 weeks after the petal-fall spray, may be required to control **apple scab.**

The same considerations exist as in the petal-fall application with respect to the choice of elemental sulfurs or liquid lime-sulfur in this application.

SUMMER SPRAYS

The purpose of the summer sprays is to control **codling moth, apple maggot, red-banded leaf roller,** and **apple scab. Orchard mites** and the **green apple aphid** may also become problems.

It is usual to include a fungicide in all summer sprays for scab control. The micro-fine paste and air-ground sulfurs cause fruit scald too frequently to be advised in summer sprays. In most years the coarser 325-mesh elemental sulfur can be substituted to reduce the danger of spray injury. In both 1952 and 1953, however, temperatures were so high that the 325-mesh sulfurs also caused injury. One of the organic fungicides discussed on pages 23 to 25 may be substituted at somewhat higher cost when high temperatures are forecast. In the cover sprays if scab control is good, captan and ferbam may be reduced to 1 pound and glyodin to 1½ pints per 100 gallons.

The summer-spray program of sulfur and lead arsenate usually controls **Brooks fruit-spot.** Small amounts of this disease appeared on susceptible varieties of apples in the Hudson Valley in 1947. In this area 1 pound of ferbam may be substituted for the sulfur when lead arsenate is not used.

In planning a spraying schedule for the summer application—that is, after the petal-fall or the curculio spray—it must be kept in mind that the regulations of the Federal Food and Drug Administration do not permit excessive amounts of spray residue on the fruit at harvest time. The present tolerances permitted on apples and pears are 0.05 grain of DDT, 0.025 grain of arsenic trioxide, and 0.05 grain of lead for each pound of fruit. The tolerances on fruits other than apples and pears are 0.01 grain of arsenic trioxide and 0.025 grain of lead for each pound of fruit. The equivalent unofficial tolerances for apples and pears expressed in parts per million (p.p.m.) would be 7 p.p.m. of DDT, 3.5 p.p.m. of arsenic trioxide, and 7 p.p.m. of lead. For fruits other than apples and pears, the unofficial tolerances

would be 1.5 p.p.m. of arsenic trioxide and 3.5 p.p.m. of lead. These tentative tolerances should not be exceeded in a normal season, provided the schedules outlined in this bulletin are followed.

The basic summer schedule follows. Suggested spray dates may be somewhat earlier in eastern New York and later in western New York than those indicated.

First codling-moth cover spray

(About June 10 to 15)

325 mesh sulfur ..... 5 pounds

or

Organic fungicide at manufacturers' directions

*DDT (50 per cent powder).. 2 pounds

Water to make ..... 100 gallons

*If you use 75 per cent DDT powder, reduce the dosage to 1⅜ or 1¾ pounds.

The first codling-moth cover spray is timed primarily to control codling moth. DDT should be used as a basic schedule in orchards with a moderate to heavy infestation. The orchardist who has had little difficulty with codling moth in the past, may use 3 pounds of lead arsenate and an equal quantity of hydrated lime as a corrective in the basic schedule. The hydrated lime should be omitted where ferbam is used.

In eastern New York orchards, an insecticide with the DDT for **plum curculio** should be included in this spray as discussed for the petal-fall spray. If parathion or methoxychlor is used, the DDT may be omitted.

For efficient control of both codling moth and mites, a mixture of 1½ pounds of 50 per cent DDT and ½ pound of parathion plus fungicide in 100 gallons of spray may be tried. This program if followed through all cover sprays, including the second-brood codling moth sprays, controls codling moth equally as well as does DDT alone. Special measures should not be required to control orchard mites and the red-banded leaf roller. It is available as a commercially formulated material (Black Leaf 253).

Caution: In a 1952 experiment this combination was ineffective against apple maggot and therefore should not be used without the addition of lead arsenate where this insect is a problem. There is also evidence that the continued use of parathion in all the cover sprays may result in resistant mite populations after several years of use.

Second codling-moth cover spray or first apple-maggot spray

(About June 20 to 28)

325 mesh sulfur ..... 5 pounds

or

Organic fungicides at manufacturers' directions

*DDT ..... 2 pounds
(50 per cent wettable powder)

Water to make ..... 100 gallons

*If you use 75 per cent DDT powder, reduce the dosage to 1⅜ or 1¾ pounds.

This spray is applied from 10 to 14 days after the first cover spray, depending upon the severity of the **codling-moth** infestation. In recent years the spray has been necessary to control apple maggot.

Evidence indicates that DDT, although effective for intervals of 10 to 14 days against the codling moth, depending upon activity, loses its toxicity to the **apple maggot fly** after approximately 10 days under average summer conditions. Where orchards are surrounded by woods or hedgerows or are within several hundred feet of unsprayed apples and apple maggot is a problem, the spray interval should not exceed 10 days where DDT alone is used. As a practical measure in lengthening the interval, a combination of lead arsenate, DDT, and lime, 2 pounds of each in 100 gallons of spray mixture, may be used at intervals of 12 to 14 days without sacrificing control of the apple maggot. You may use this mixture until about July 20 in eastern New York and until near August 1 in western New York with-

out exceeding residue tolerances on varieties such as McIntosh and Cortland and is recommended where apple maggot is a serious problem.

Examine the trees carefully before applying this and following sprays, to determine whether **European red mites** or **two-spotted spider mites** are building up. If there are from 4 to 6 mites on leaves in June, July, or early August, apply tetraethyl pyrophospate (TEPP) at manufacturers' directions, either added to the spray mixture or supplied as a separate spray. Parathion at 1 pound of 15 per cent wettable powder or EPN at the rate of ½ pound in 100 gallons of spray mixture may be used. The EPN kills mites over a longer period than either parathion or TEPP but the killing action is slow at first. EPN is injurious to foliage and fruit of McIntosh and its relatives. At present there is no way to correct the injury and it is therefore not recommended on these varieties. Two sprays are generally necessary with all these materials because they are not very toxic to the eggs. They should be applied at a 7- to 10-day interval; the shorter interval during periods of warm temperature and the longer interval during cooler temperatures. Do not use TEPP with bordeaux mixture or lime. If resistant mite populations develop after the extensive use of any of the above materials, Aramite (1½ pounds per 100 gallons of spray), Dimite (1 pint to 100 gallons of spray) or Ovotran (½ pound to 100 gallons of spray) may be used on a trial basis.

If you used parathion in the petal-fall and curculio sprays or dormant oil, special summer treatments to control European red mite are not needed except in unusual seasons or where mites have escaped earlier treatments due to poor coverage. Infestations of **two-spotted** or **four-spotted** mites seldom begin to build up in fruit trees before August but may continue to build up through harvest time. The same control measures suggested for European red mites are useful for two-spotted mites, but two applications may not be enough.

Tetraethyl pyrophosphate at manufacturers' directions or parathion at 1 to 2 pounds of 15 per cent powder, may be included as a summer control for **green apple aphids** when they appear.

Malathion at the rate 1 to 2 pounds to 100 gallons of spray may be used on a trial basis. It is also suggested a dormant or delayed-dormant treatment be included in the program as discussed on page 6. The use of summer oils with DDT may burn the foliage and greatly increase toxic residue at harvest time.

If **scab** is under control, a fungicide may not be needed in this spray. Where lead arsenate is to be used in the third cover spray and scab is under control after the first cover spray, the fungicide may be omitted in some of the other cover sprays; the omission is advisable during or preceding periods of extreme heat. Some growers prefer to use a 2–8–100 bordeaux mixture as the fungicide in this and later sprays. This mixture is superior to proprietary copper sprays in scab control, and helps to reduce arsenical injury. The bordeaux should be reduced to a ¾–3–100 concentration where scab control is not needed but arsenical injury is a problem. The use on apples of any copper compound now known is attended with some danger of injury to foliage and fruit in this State. The most dangerous period is from the delayed-dormant spray through the first cover spray. Any of the later sprays also may be injurious. It may be best also to lengthen the interval between applications from 12 to 14 days.

Third codling-moth cover spray or second apple-maggot spray

(About June 30 to July 10)

Same as second codling-moth cover (page 14).

If **apple scab** is not a problem, you may omit the fungicide from this spray. Watch the orchard carefully for **mites** and, if a

problem, follow the suggestions in the second codling-moth cover spray.

Fourth codling-moth cover spray or third apple-maggot spray

(About July 10 to 18)

Same as second codling-moth cover spray (page 14).

This spray is effective for the control of **codling moth** and **apple maggot.** It may not always be needed to control codling moth, depending on the seasonal development of this insect. When DDT is used for the control of **apple maggot,** it would be advisable to add from 2 to 3 pounds of lead arsenate plus 2 pounds of lime to extend the effectiveness of this spray. If first-brood codling moth activity has diminished, the DDT may be omitted. Apple maggot is normally at the peak of its activity through this period. If a mite infestation is present, the suggestions made under the second codling-moth cover spray concerning the presence and control of mites (page 15) should be followed.

For a spreader at this time ¼ pound of skimmilk powder or ½ pound of soybean flour may be used with the lead-arsenate program. Where arsenical injury is a problem, you may add 2 pounds of hydrated lime for each pound of lead arsenate. A ¾–3–100 bordeaux mixture is more effective in this respect than is lime alone.

The nicotine compounds, parathion and TEPP, apparently are not effective against apple maggot. To control apple maggot satisfactorily, thoroughly spray all trees in infested orchards. This applies not only to apple trees in their off-bearing year, but also to other fruits interplanted with apples. Experience has shown that failures to control the apple maggot are especially likely to result if spraying is confined to trees with fruit. Hedgerows, neglected orchards, and scattered trees near and adjoining commercial plantings should also receive the maggot sprays.

Second brood codling-moth and red-banded leaf roller cover sprays

(First three weeks in August)

Fungicide at manufacturers' directions
DDD (TDE) (50 per cent wettable powder) ..... 2 pounds
Water to make ..... 100 gallons

This spray is applied about August 1 in eastern New York and about August 7 in western New York. This provides protection against **red-banded leaf roller, codling moth,** and **apple maggot.** It is important to direct this spray to the underside of the leaves or it will be ineffective against red-banded leaf roller. DDD offers no protection against orchard mites. If the two-spotted mite is a problem at this time of year, follow the recommendation on page 15 under the second codling moth cover spray.

Parathion may be substituted for the DDD at the rate of 1½ pounds in 100 gallons of spray mixture subject to the restrictions noted on page 94. Parathion provides protection against red-banded leaf roller, codling moth, and orchard mites but its efficiency against apple maggot does not extend beyond 3 to 5 days according to present information. Therefore, it does not seem wise or practical to use this material in areas troubled with the apple maggot.

The combination of 1½ pounds of 50 per cent DDT and ½ pound of parathion may be substituted for the DDD in the above mixture provided another spray treatment is made in 10 to 12 days. Good control of second-brood codling moth and reasonable control of orchard mites will be obtained and somewhat poorer control of red-banded leaf roller will result than if the DDD were used. This combination has not been effective against the apple maggot and is not advised in areas where this pest is a problem, particularly in the Hudson Valley area.

Lead arsenate, 3 pounds in 100 gallons of spray mixture plus 3 pounds of lime, may be substituted for the DDD in the

above formula but it should be used only in orchards where it has been used in the past with relatively good results. The use of lead arsenate in August creates excessive residues on earlier varieties such as McIntosh and Cortland.

DDT may be substituted for the DDD in the above formula where red-banded leaf roller is not a problem for control of codling moth and apple maggot.

Special sprays

In some years late activity of **codling moth, apple maggot,** or **orchard mites** requires special treatment during August. These treatments become increasingly uneconomical as the season progresses and should be made only when absolutely necessary. The local county agricultural agent or Spray Information Service Letters where available tell when these sprays are necessary.

At this time of year excessive residues are as important to prevent as is insect damage. The most practical material to use on most varieties is methoxychlor at the rate of 2 pounds in 100 gallons of water where late codling moth or apple maggot are to be controlled. A treatment should be made between August 10 and 20. One or two applications of 5 per cent DDT dust serves the same purpose. If red-banded leaf roller still persists due to faulty coverage, the DDD formula may be repeated on varieties harvested later than Cortland.

DUSTING FOR APPLE SCAB

For scab control, experimental work shows sulfur dusts are most effective when applied during rain before infection occurs. The finer divided dusts are more adherent than the coarser forms. For this reason, the orchardist should insist on a dusting sulfur equal in fineness to the dry wettable sulfur even if the cost is higher.

DESCRIPTION OF DISEASES AND INSECTS

PLANT LICE

Three species of plant lice, or aphids, may appear on the opening buds of the apple: the apple grain aphid, the green apple aphid, and the rosy apple aphid. All three of these species of plant lice pass the winter in the egg stage on the bark of the apple. The eggs, about $^{1}/_{50}$ inch long, are black, shiny, and elliptical in shape. The grain aphids hatch just as the buds are showing green, and the green and rosy aphids appear from 1 week to 10 days later. In normal seasons, all three species have completed hatching by the time the leaves of the blossom clusters are out ½ inch and are beginning to turn back at the tip.

Apple grain aphid

(Rhopalosiphum prunifoliae Fitch)

The grain aphid is usually the most abundant species on the opening buds. The newly hatched aphids are dark yellowish green, and may be distinguished under a strong lens by the cornicles, which are so short as to appear like low tubercles (figure 7, C). The majority of the second generation acquire wings and migrate to their summer food plants without causing any serious injury to the apple. This species lives on grains and grasses until October or November, when males and females are produced. These return to the apple, where the winter eggs are deposited.

Rosy apple aphid

(Anuraphis roseus Baker)

Usually, the rosy aphid is by far the most destructive of the species of aphids that attack the apple. It varies greatly in abundance from year to year. Major outbreaks have occurred at intervals of several years in eastern New York, and in some seasons the rosy aphid is so scarce as to

cause practically no damage. In western New York, outbreaks of this pest are periodic, but the insect may be injurious for several years in succession. In most years, however, this aphid is present at least in small numbers in all orchards. The rosy aphid dwarfs and deforms the fruit, rendering it unmarketable. It is most destructive to Baldwin, Rhode Island Greening, Cortland, Rome Beauty, Jonathan, Maiden Blush, Twenty Ounce, and Northern Spy. Varieties such as McIntosh, Duchess, and Wealthy usually escape serious injury.

The newly hatched nymphs are very dark green, and may be distinguished from the other species by the longer cornicles, which are flanged at the tip (figure 7, *B*.) The mature aphids vary considerably in color, but are usually of a dark bluish slate color and are covered with a waxy bloom or powder. The rosy aphid has the habit of clustering on the leaves of the fruit spurs and on the stems of the young fruits, as well as on the fruits themselves. Apples injured by the rosy aphid are dwarfed, deformed, poorly colored, characteristically puckered at the blossom end, and tend to cling to the tree in clusters through the season. The feeding of the rosy aphid on the leaves causes them to curl tightly and roll up diagonally like a cigar wrapper. The curled leaves protect the lice not only from heavy rains but also from the spray. The majority of the third- and fourth-generation aphids acquire wings and migrate to narrow-leaved plantain, where they remain until late autumn.

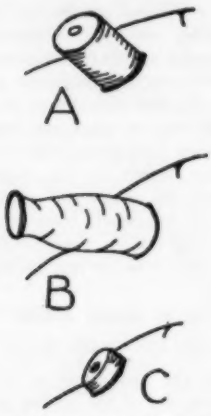


FIGURE 7. CORNICLES OF THE NEWLY HATCHED STEM MOTHERS

A, apple aphid; B, rosy aphid; C, grain aphid

The cornicles are two small tubes projecting from the back of the insect near the hind extremity.

Control

The most effective way to control rosy aphid under commercial conditions has been the use of DNC and DNBP compounds which are directed at control of the egg stage. Investigations show fall applications of DNC to be as effective as spring or winter applications. Two points should be kept in mind when making fall treatments: (1) Make the applications after the leaves have fallen from the trees and (2), because DNC materials kill only the aphid eggs that are hit by the spray, delay the applications until after the temperature reaches about 20° F. for a day or so. The aphids do not stop depositing eggs until a temperature of about 20° F. has been reached. DNBP materials are unsafe to use in the fall.

If it is impossible to apply the DN spray because of unsatisfactory weather or orchard conditions, BHC may be used at the rate of 2 pounds of a 10 per cent gamma isomer powder or the equivalent in other strengths or lindane at 1 pound of the 25 per cent powder in the bordeaux-oil formula. This spray is not so efficient as the DN spray in most years for several reasons: (1) Since the spray is applied at the full delayed-dormant stage when all of the aphids have hatched, it is most difficult to get the thorough coverage necessary to kill the active aphids. (2) Since this is the last stage of development in which good aphid control is possible, such adverse conditions as high winds or deep

mud may cause the grower who depends on this spray to forfeit his chance. Nicotine sulfate has been widely used in the past for this purpose, but it does not effectively control aphids unless warm, still conditions prevail and in many seasons such conditions are not readily found.

Applying the spray

The rosy aphid is a difficult pest to control and satisfactory results are obtained only where the spray is applied with extreme thoroughness and care. If you use a treatment that is directed at the aphid eggs before they hatch, you may spray one side of the tree with the wind on one day and cover the other side when the wind changes. Be careful not to overlap the spray on some parts of the tree when you make the second application. This system does not always prove satisfactory, however, because warm weather may advance the buds too far for safety while you wait for the wind to change. Each grower will need to watch the situation carefully and to adopt the system of spraying which best fits his own conditions.

Apple aphid

(Aphis pomi DeGeer)

The apple aphid has a tendency to attack the tender growing shoots and its most serious injury is the dwarfing of new growth of nursery stock and young plantings. In occasional years, however, it causes serious injury to fruit and foliage in bearing orchards.

The newly hatched nymphs of this species are dark apple-green in color, and may be distinguished under a lens by their short, cylindrical cornicles (figure 7, *A*). The apple aphid lives on the apple throughout the season, but many individuals of the second and third generations acquire wings and migrate not only to other apple trees but also to pear, quince, and spiraea.

In some seasons, the apple aphid may become extremely abundant, especially on the terminal shoots of young trees. Occasionally, fruit on bearing trees may be seriously damaged; the apples may become dwarfed, misshapen, or assume a pitted appearance. The aphids also cover the fruit and the foliage with sticky honeydew, on which a black, sooty fungus grows that often stains the fruit so badly as to greatly reduce its market value.

Control

The apple aphid in bearing orchards is to a large extent controlled by the treatment given for the rosy apple aphid (page 18). These sprays do not insure complete protection from apple aphids throughout the season, because, beginning with the second generation, a large proportion of the green aphids are winged, and in years of summer outbreaks they migrate in considerable numbers and infest clean orchards. As a general rule, however, trees receiving early season aphid sprays are less likely to be seriously infested by the apple aphid in the summer season.

When there are summer outbreaks, remove all suckers and water sprouts from the trees; the aphids breed on these in large numbers. When green aphids appear in considerable numbers on the terminals of bearing trees, watch them closely. As long as they confine their feeding to the terminal shoots and the leaf clusters, a special spray may be withheld in the hope that natural agencies will keep the aphids within bounds. If, however, the aphids invade the fruit clusters, apply spray at once with one of three materials. TEPP is probably the most dependable summer aphid control when used at the rate of ¼ to ½ pint in 100 gallons of spray. Parathion is also effective at the rate of 1 pound of 15 per cent powder in 100 gallons, but do not use it on McIntosh, Cortland, and other varieties of McIntosh parentage, such as Milton and McCown. Nicotine sulfate, 1 pint combined

with from 3 to 5 pounds of potash fish oil soap or 1 pound of soap flakes in 100 gallons of spray mixture has been extensively used in the past. The amounts of TEPP and parathion suggested for aphid control are the same as those suggested for orchard mite control. A newer material, malathion, may also be used at the rate of 1 pound of the 25 per cent powder.

APPLE SCAB

(Caused by the fungus *Venturia inaequalis* (Cooke) Winter)

The commonest and most destructive disease of apples in New York is apple scab. Every fruit grower knows the tremendous damage to the apple crop caused by scab. It is less well known that, in some years, early scab infection on the fruit pedicels, when not controlled, almost entirely prevents the setting of fruit. Another loss not always recognized is the weakening of the trees following severe leaf infection, a condition which results in the reduction of later crops.

The scab fungus commonly affects the fruits and the leaves, but it may be found also on the leaf stalks, on the flowers, and, rarely in New York, on the twigs.

The first appearance of the scab on the leaves is a dull, smoky area that is difficult to see without careful examination. A little later the spots become more olive-colored, velvety, and much more noticeable. If leaf infections occur before the leaves of the clusters have rolled back, many of these spots will be found on the under surface of the leaves.

FIGURE 8. APPLE SCAB ON THE UPPER AND LOWER SURFACES OF LEAVES AND ON THE FRUIT

The first infections on the fruit may be on the sepals when only silver or green tips are showing on the fruit buds. These sepal infections resemble closely the leaf infections, and are often overlooked. When sepal infections are present, the scab fungus later spreads from them to the surface of the fruit, resulting in scab spots near the calyx end of the apple. The spots on the fruit itself, regardless of their source, first appear as small, circular, olive-colored areas; but later, as the fungus spreads and the fruit grows, the familiar scabby spots appear (figure 8). Sometimes these scabby spots are accompanied by a cracking of the fruit.

The appearance on the leaf stalks and on the flowers is similar to that on the leaves. The scab spots on the twigs vary with the variety of apple, but often become somewhat swollen, with a blistered or a scurfy appearance.

Apple scab is caused by a fungus that overwinters in the old fallen leaves as partly grown fruiting bodies. These fruiting bodies ripen in the early spring. The date of ripening varies slightly with the variety of apple, but is largely determined by weather conditions. In New York, in most years, these fruiting bodies (perithecia) are ripe and ready to discharge their first spring spores (ascospores) by the time the delayed-dormant spray is applied; that is, when the leaves of the blossom buds are out from ¼ to ½ inch. Rain for a few minutes is enough to wet the old leaves on the ground and to cause the ascospores to shoot out about ¼ inch from the leaves. Air currents then carry the light spores long distances, and many of them settle on the green parts of the apple trees. This shooting of spores continues, during wet weather, for from four to six weeks. The supply of ascospores is usually exhausted from two to four weeks after the petals have fallen in western New York and from four to seven weeks in eastern New York.

If the green tissue is wet when the spore lodges, and remains wet long enough, the spore will germinate and send its sprout, or germ tube, into the tissue. The time required for the spore to germinate and grow into the tissue varies greatly with the temperature.

If mature perithecia are present, the approximate number of hours of wetting required in the orchard at various average temperatures for light, moderate, and heavy primary (ascospore) infection of young leaves is shown in table 1. Blossom buds and very young fruits require about the same wetting period at the various temperatures for infection. The time is computed from the beginning of the rain period until the leaves are completely dry. If showers are intermittent, the wetting periods should be added together unless a half day or more of dry sunny weather intervenes. The scab spores survive much longer dry periods, but discontinuous wetting has very rarely been important in the orchard. Apparently the

TABLE 1. APPROXIMATE HOURS OF WETTING REQUIRED FOR PRIMARY (ASCOSPORE) LEAF-SCAB INFECTION IN THE ORCHARD

Temperature (F.)	Infection		
	Light	Moderate	Heavy
Degrees	*Hours*	*Hours*	*Hours*
78	13	17	26
77	11	14	21
76	9⅓	12	19
63 to 75	9	12	18
62	9	12	19
61	9	13	20
60	9⅓	13	20
59	10	13	21
58	10	14	21
57	10	14	22
56	11	15	22
55	11	16	24
54	11⅓	16	24
53	12	17	25
52	12	18	26
51	13	18	27
50	14	19	29
49	14⅓	20	30
48	15	20	30
47	17	23	35
46	19	25	38
45	20	27	41
44	22	30	45
43	25	34	51
42	30	40	60
33 to 41	More than 2 days		

leaves rapidly become resistant to infection under orchard conditions.

To obtain an approximate temperature, the high and the low temperature during the wet period are averaged. If this average temperature is 50°F., the time of wetting required for light infection is 14 hours (table 1).

After the fungus has penetrated the leaf cuticle, it grows under it for from 8 to 18 days, depending on the prevailing temperature, and then sends up stalks on which the summer spores, or conidia, are borne. After these conidia become numerous, the lesion may be seen as a dull spot when the leaf is held in the sunshine at an angle which causes the leaf surface to shine. A few days later the spot will be brown and easily seen on the leaf. The conidia when dry are firmly attached to the stalks bearing them and are not loosened by wind; when wet, they promptly become detached and are washed to new locations. The conidia are not blown long distances by wind as are the ascospores from the overwintered leaves on the ground but are scattered only so far as the water drips, runs, or is splashed or blown. These summer spores, carried by water to other leaves or fruit, germinate and send germ tubes into the tissue to form new spots. This continues during rain periods throughout the summer. The time required for this secondary infection on young leaves from scab lesions is apparently about one-third shorter than indicated in table 1 for primary infection at the same temperature.

When scabby leaves drop to the ground, the scab fungus sends hyphae down through the leaf tissue beneath the spots. Some of these hyphae fuse together and start the development of the fruiting bodies, or perithecia, in the leaf tissue. These perithecia mature early the following spring and discharge the spring spores (ascospores) to start scab infection for another season.

Control

From a study of the life history of the scab fungus, it would seem that the disease might be controlled by destroying the dead leaves in which the fungus overwinters. Plowing under the leaves reduces greatly the number of fruiting bodies and of ascospores discharged in the spring. Unfortunately, this has not been found to be of much practical benefit, for, with the most careful work, there are still many leaves left uncovered around tree trunks, along fences, and in other protected places. One tree may have enough leaves under it for 2,000,000,000 spores, so if 90 per cent were destroyed there still would be enough left to give abundant infections.

Another way to destroy the overwintering stage of the scab fungus is to spray the scabby leaves before they have dropped, to prevent the formation of perithecia. Lime-sulfur is ineffective for this purpose. Even two sprays of lime-sulfur on scabby McIntosh leaves are ineffective in preventing the development of large numbers of perithecia. Other more toxic sprays applied after picking have been tried, but no material has been found that is effective against the scab fungus and that does not injure the trees under New York conditions.

Spraying the ground in early spring to destroy the overwintering scab fungus in the fallen leaves has been extensively tested in this and other States. The results of nine-years experimentation in the Hudson Valley have been published in New York State (Geneva) Agricultural Experiment Station Bulletin 714, *Ground Treatments as an Aid in Apple Scab Control.*

The most effective material in these experiments was sodium-dinitro ortho cresol (DNC) sold under the name of Elgetol. Krenite containing the same ingredients appears equally effective. Another dinitro material contains in solution the triethanolamine salt of dinitro secondary butyl phenol (DN–289, Elgetol

318). This DNBP appears in orchard tests to be slightly less effective as a ground spray for eradicating apple scab than the materials already discussed.

Thoroughly spray the orchard floor with from 400 to 600 gallons of dilute paste DNC to the acre, depending on the height of the grass or cover crop, at a concentration of ½ gallon in 100 gallons of spray. The ground spray is best applied in the dormant period but may be applied through the green-tip stage of the trees. If you use the same chemical for a dormant tree spray to control insects, you may combine the tree and ground spray in one treatment. Take extra time to drench fence rows and other areas where the leaves are piled up. The material soaks through the leaf mat, so agitation of the leaves is not required.

Ground sprays are most valuable in orchards that have a heavy carryover of scab and in isolated orchards. If there are long periods of wetting, ascospores from other orchards may blow in and still have wet conditions long enough to cause serious amounts of infection. When the wet periods are barely enough for infection from leaves in the orchard, the ground sprays are effective. It is, however, not safe to omit any of the prebloom sprays because a ground spray has been applied. A thorough community program of ground sprays should be valuable in the intensive apple-growing areas.

The practical method of control is to cover the fruit and leaves with a protective coating of a material that prevents the spores from germinating and entering the tissue. The most common materials for the purpose have been sulfur and copper. Sulfur is commonly used in the form of lime-sulfur spray and in elemental-sulfur sprays and dusts. Copper is used in the form of bordeaux mixture and in several proprietary compounds. Under New York conditions the danger of injury to the fruit and leaves of apple from copper compounds is great, and some years ago sulfur compounds and organic fungicides almost entirely supplanted them except for the bordeaux-oil spray in the green-tip stage.

A number of organic compounds suggested for scab control are now on the market. The oldest and most widely tested of these organic fungicides is ferbam (Ferric dimethyl dithio carbamate). This compound is on the market under a number of trade names. Over a decade this material used at the rate of 1½ pounds per 100 gallons of spray as a protectant has been about equal to the most finely divided dry wettable sulfurs and slightly inferior to the better paste sulfurs used at a rate of 5 pounds of actual sulfur per 100 gallons in control of leaf scab but is equal to the sulfur in the control of fruit scab.

Ferbam showed some degree of after-rain control in 1953 and in occasional earlier years but cannot be relied upon for this purpose. Ferbam is the most effective fungicide in the control of the cedar rusts and may be used with sulfur or other organic fungicides for combined control of scab and rusts. Ferbam causes only slight injury to foliage even in hot weather, but caused considerable enlargement of fruit lenticles and appreciable fruit russeting during 1951, 1952, and 1953. Ferbam is considered incompatible with lime-sulfur or copper compounds. It is unsafe with some commercially prepared dormant oil sprays but is safe with the tank-mixed oils recommended in this State.

Ferbam is an adequate arsenical corrective for lead arsenate on apple and shows an increase in yield over sulfur-lead arsenate schedules without lime. Lime should not be added to fermate since a base exchange occurs and the iron salt, ferbam, which is relatively insoluble and safe becomes the soluble and more toxic calcium salt.

The phenyl mercury sprays show considerable value as spray eradicants, and are, therefore, effective as after-rain treat-

ments. Phenyl-mercury acetate has been sold as Tag 331, Puratized Apple Spray, and other names. The lactate compound sold as Puratized Agricultural Spray has been tested most extensively of the organic mercury compounds. A powdered form of phenyl mercury acetate (coromeric) is on the market.

The phenyl mercury compounds tend to be effective for a longer time than liquid lime-sulfur when applied after a scab-infection rain. The period of effectiveness in after-infection treatments varies with the temperature. At optimal temperatures for scab development, the period may approximate 70 hours; with temperatures in the 40's, control may be obtained for 5 days after the beginning of the scab rain. There has appeared to be little difference over the years between the lactate and the acetate salts either in scab control or in injury.

Lime-sulfur, while an excellent protectant and a good after-rain treatment, has been largely discarded by New York growers because severe injury often followed its use on wet foliage during bloom or during or preceding high temperatures. The phenyl mercuries have been found to cause injury to a somewhat lesser degree under the same conditions favoring lime-sulfur injury. Experiments conducted over a period of years in this and other States showed that lime-sulfur caused lighter bloom and smaller yields than the elemental sulfurs. The effects were cumulative and were not striking until the third and succeeding years after the differential sprays were applied. Such long-term tests have not been conducted on the newer fungicides being used in after-rain sprays such as the phenyl mercuries and the napthoquinone, or on the combination sprays containing half-strength mercurials or napthoquinone with sulfur or some other protectant fungicide. Some of the preliminary results of the past two years indicate the possibility that the half-strength eradicants may also reduce the amount of bloom and of the fruit set.

Phygon, a napthoquinone compound, is an effective eradicant fungicide against apple scab, but Phygon in a seasonal schedule has caused a serious reduction in bloom and fruit set the following year. It caused serious russeting on several apple varieties in a 1952 test in the Hudson Valley. Apparently this fungicide is less safe under Hudson Valley conditions than in northern New England and in the Champlain Valley. Russeting also occurred in western New York in the past two years. Single applications, particularly in dust form, are much less injurious. Like the mercury compounds, Phygon is most effective when used as an eradicant rather than as a protectant. It is effective for about 50 hours after a scab infection in greenhouse experiments which is approximately the same period as with lime sulfur and considerable shorter than with the phenyl mercuries.

Both the mercurials and the naphthoquinone materials while good eradicants have been shown to be inferior to flotation sulfur paste when applied as a protectant against apple scab. The phenyl-mercury materials also have some eradicant value when sprayed on newly developed scab lesions but are relatively ineffective on well-established lesions on old leaves. In past years, the mercury sprays in bloom had apparently caused no injury to foliage, fruit set, or to bees. In 1953, serious reduction in set followed bloom sprays of mercury. Post-bloom sprays of mercury preceding or during hot weather have caused leaf injury and drop, and in some instances fruit drop as well. Mercury should not be used after the petal-fall spray.

Glyodin (Crag fungicide 341) is an extremely persistent protective fungicide. It is a solution of 2 hepta decyl glyoxalidine. Used at 1 quart per 100 gallons through primary scab and at 1 to 1½ pints later, glyodin is an effective protectant fungicide. It possesses little or no after-infection

control. The commercial solution should not be used at more than 1 quart per 100 gallons in the early sprays or more than 1½ pints in the cover sprays. Lime at 1 ounce per 100 gallons has been recommended but has not been found needed with any of the spray waters used in New York. At higher dosages, McIntosh fruits may be advanced in maturity in some seasons. Some late-leaf injury appeared in 1952 and 1953 when glyodin was used with lead arsenate on Rhode Island Greening, Baldwin, Jonathan, Cortland, and Rome varieties. Brown spots appeared on the leaves but did not appear to be serious. A considerable number of orchards of these varieties receiving glyodin and lead arsenate in 1953. Serious injury was limited to a few orchards in very low vigor due to low nitrogen or to poor fruit soil. Glyodin in combination with DDT caused no spotting of Cortland leaves in a 1953 experiment, while spots were present in combination with 2 or 3 pounds of lead arsenate per 100 gallons of spray. The mixture of 1 pint of 341 with half strength mercury has given excellent control when combined protection and after-rain control were needed. This mixture has caused no injury to foliage or fruit in pre-cover sprays during the past four years. It would seem wise to limit the combination sprays to periods when both eradication and protection is necessary since the long-time effect of even half-strength mercurials on fruit yield is uncertain.

Captan is a recent promising addition to the organic fungicides for use on apple. Captan (Orthocide 406 and Captan 50W) is a wettable powder containing 50 per cent 4-N trichloro ethyl hydrophthalamide. Captan has usually given higher finish fruit on Delicious and Golden Delicious than any other fungicide in 1951, 1952, and 1953. In 1953 in the Hudson Valley serious russet was reported in one instance from captan at 4X concentration. Moderate leaf spotting of (red) Delicious and Baldwin appeared in 1952 soon after the petal-fall stage and was more severe in 1953 causing yellowing and dropping of blossom cluster leaves in both varieties. In one replicated test of Delicious in Ulster County receiving captan as the fungicide the number of spotted leaves was significantly higher (0.01 level) on the trees receiving a bordeaux-oil spray in the green-tip to delayed-dormant stage. In other orchards, there was considerable spotting where no oil was applied prior to the captan sprays. In most instances the leaf injury to either Delicious or Baldwin was not serious. Captan possesses some after-rain control but cannot be relied upon for more than 18 hours from the beginning of the rain. Captan at 2 pounds per 100 gallons also appears strongly fungistatic on scab lesions, thus preventing secondary infection if frequently applied. Lime reduces the fungicidal action of captan and should not be added to captan–lead-arsenate sprays. Captan has some corrective effect on lead arsenate but will not prevent arsenical leaf spotting on susceptible varieties when 3 pounds of lead arsenate is used. Captan is relatively poor in adherence and combinations with more retentive fungicides, such as glyodin, appear promising.

Other organic fungicides are under test on fruit but have not been evaluated enough to include here. All of the organic fungicides now being used are more expensive than the elemental sulfurs. It is possible that increased yields by some of the fungicides over the use of sulfur may justify their increased cost. Until this is proved it would seem that the use of elemental sulfurs in as many of the early sprays as conditions will permit will effect a considerable economy for the fruit grower.

In a cooperative experiment in New York in 1952 under conditions favorable for apple-scab infection, the use of parathion allowed significantly more scab to develop in combination with seven fungicides than where parathion was not used. Similar increases in scab with parathion

were reported in 1952 from West Virginia, Virginia, and Michigan. West Virginia again reported increases in scab and decreases in fruit set in 1953. In ten grower-sprayed demonstrations in New York in 1953, parathion in sprays following bloom caused moderate increases in leaf scab in four orchards. In the other six orchards where scab was very slight or absent, there was no increases on the parathion-sprayed trees. In the first year of a tree-response experiment in western New York with no scab present, no scab developed on foliage or fruit of trees sprayed with parathion. Decreases in yield in the grower-sprayed orchard were small but significant. In the response experiment, decreases in yield by parathion were not significant. In one grower-sprayed demonstration where parathion was used during the delayed-dormant period when conditions favored heavy scab infection, the scab was strikingly more severe on the parathion-sprayed rows.

The great increase in scab by parathion in 1952 was when the parathion sprays were applied during a period conducive to severe scab infection. The small increases in scab with parathion in 1953 were in the orchards where the parathion was applied after the period of heavy scab infection was past and only those orchards with appreciably leaf scab from early infection showed increases from parathion.

It might be wise to wait until time for parathion sprays to make your decision as to when to spray. If primary scab infection is about over and there are not many scab spots present, you would be justified in using parathion. If inoculum is still present and weather favorable to scab infection is forecast, you might very wisely use one of the other programs rather than parathion. This would be particularly true if scab lesions were already easy to find on your foliage.

The reason for frequent applications of protectant sprays during the early part of the season is not to renew the coating on the surface but to cover the new growth. Before blossoming, the apple tree frequently unfolds two or three new leaves in a day and the leaves that are already out increase rapidly in size. Later in the season, growth is much slower and less frequently applications are required.

It is obvious from a study of the life history of the scab fungus that the most dangerous period is from the time when the fruiting bodies in the old fallen leaves are ripe until all their spores are shot. This is usually from the time of the delayed-dormant spray until a month after the petal-fall application. If you have protected the new growth of leaves and fruit through the rain periods until there are no more spores from the dead leaves, special applications directed against scab are not needed for the rest of the season. On the other hand, if the trees have gone through a single rain-infection period without protection and many of the leaves have become infected, later spraying or dusting will not insure a clean crop no matter how frequently it is done.

The success or the failure to control scab is almost entirely dependent on the proper timing of thorough applications in the early part of the season. If you make no application until after a long rain-infection period, control is difficult if not impossible. On the other hand if you make an application a number of days ahead of the rain period, new growth may develop in the meantime that will be unprotected during the rain. For best results with protectants, apply the spray just before the rain period or during the rain before there is any infection.

The first danger of apple-scab infection is on the sepals when the fruit buds swell and show silvery tips. Sepal infection may also appear when the blossom buds are showing from 1/8 to 1/4 inch of leaf. Sepal infection is unusual in New York and in most years it is not necessary to spray for scab control before the delayed-dormant stage. Sepal infection was, however,

general and serious in western New York in 1951 and locally serious in 1953. There were small amounts of sepal scab in the southern end of the Hudson Valley in 1952 and it was abundant and serious in that area in 1953. The development of the scab fungus is followed in both areas and growers are warned if scab spores are mature at the silver-tip or green-tip stage and infections are possible. Under such circumstances a special early application of a fungicide may be needed before the bordeaux-oil mixture usually applied in the green-tip or delayed-dormant stage. The dinitro sprays applied in the green-tip stage for insect control cannot be expected to give any appreciable scab control.

Usually, the delayed-dormant spray is important in scab control, and a fungicide at this stage cannot be safely omitted anywhere in the State. The proper timing of the delayed-dormant spray has been a difficult problem. It was necessary to know (1) the stage of development of the scab fungus in the old fallen leaves, (2) the weather forecasts, (3) the development of the apple buds, and (4) the development of the apple aphids, if nicotine was used in this spray for aphid control. The increasing use of dormant and green-tip sprays for aphid control allows more latitude in timing this spray for scab control. The spray information service of the farm bureaus has been able to ascertain these facts and to time properly the delayed-dormant application. No exact rule can be given, but usually the leaves of the blossom buds are out from ¼ to ½ inch when this application is made.

The pre-blossom application or applications, made between the delayed-dormant period and the bloom, present a still more difficult problem. An application during this period is almost always of importance in scab control. Two pre-blossom applications between the delayed-dormant spray and the bloom may be needed in some years. *The important considerations in timing the pre-blossom treatment are (1) weather forecasts, (2) amount of growth since last application, (3) development of apple buds, and (4) development of fruiting bodies of the fungus in the fallen leaves.* It is essential to have as reliable a weather forecast as possible, preferably for three days ahead. If there has been much new growth since the delayed-dormant period, and rains are coming, apply a cover even though only a few days intervene. If the clusters of fruit buds are exposed and the bud stems are elongated when the application is made (figure 4), adequate protection probably will be obtained through the blossoming period. On the other hand, if you make an application because of approaching rain, when the buds in the cluster are still short-stemmed and closely packed together, a second application will be needed just before the bloom (figure 5), to give protection until the petal-fall application. In general, the practice is to delay the application after the delayed-dormant period as long as the weather permits with safety, so only one pre-blossom application will be made, as close to blossoming as possible.

In seasons when the bloom period is unusually long and rainy, bloom applications of elemental sulfur or other protectant fungicide are valuable aids in scab control. Yield may be reduced by these bloom applications so apply them only when the amount of bloom and pollinating conditions have been adequate and a need for their use for scab control exists.

The petal-fall application is usually important in scab control.

A spray or a dust is advisable, in most seasons, about ten days or two weeks after the petal-fall spray. This is necessary when many ascospores are still present in the overwintered leaves or when scab spots have appeared on the new leaves.

The seasonal control of apple scab thus consists of a delayed-dormant treatment, one or sometimes two pre-blossom appli-

cations, in many seasons a bloom application, in every year a petal-fall application, and in most years a scab spray about ten days after the petal-fall application. A fungicide included in the later applications for apple maggot and codling moth is ordinarly enough for scab control during the summer.

For these applications, sulfur is usually used as elemental sulfur in sprays or dusts. Lime-sulfur lowers photosynthesis and frequently reduces leaf growth and fruit yields. It is particularly injurious when used in the petal-fall spray. Many of the better growers keep lime-sulfur or mercurial sprays on hand but use them only when after-infection control is needed.

Of the elemental sulfurs used for sprays, paste sulfur is more effective than any of the dry wettable sulfurs. The finest divided forms of dry wettable sulfurs are nearly as effective as the paste sulfurs.

The coarser (325-mesh) dry wettable sulfurs are inferior to the finer sulfurs early in the season but are adequate for scab control in the summer. The 325-mesh sulfur causes much less sulfur sunscald to the fruit during hot periods than even reduced dosages of the more finely divided sulfurs. During the extremely hot summer of 1952 there was considerable injury with the 325-mesh sulfurs particularly in the Hudson Valley. There was also some injury, largely fruit scald, in 1953 during the heat period in June.

Experimental work with sulfur dusts shows that dusting during rain is the most effective method. The most finely divided dusts have been shown to be more adherent and to give scab control through much longer rain periods than do the coarser forms. Insist on a dusting sulfur equal in fineness to the dry wettable sulfur sold even if the cost is slightly higher.

Dust mixtures containing phygon and mercury have both shown considerable promise against apple scab when the situation requires some degree of after-infection control.

FIRE BLIGHT

(*Erwinia amylovora* (Burr.) Winslow et al)

Fire blight, a bacterial disease, is often serious on apples as well as on pears. The same life history and control measures apply to both fruits. (*See* Pear, page 53.)

EYE-SPOTTED BUD MOTH

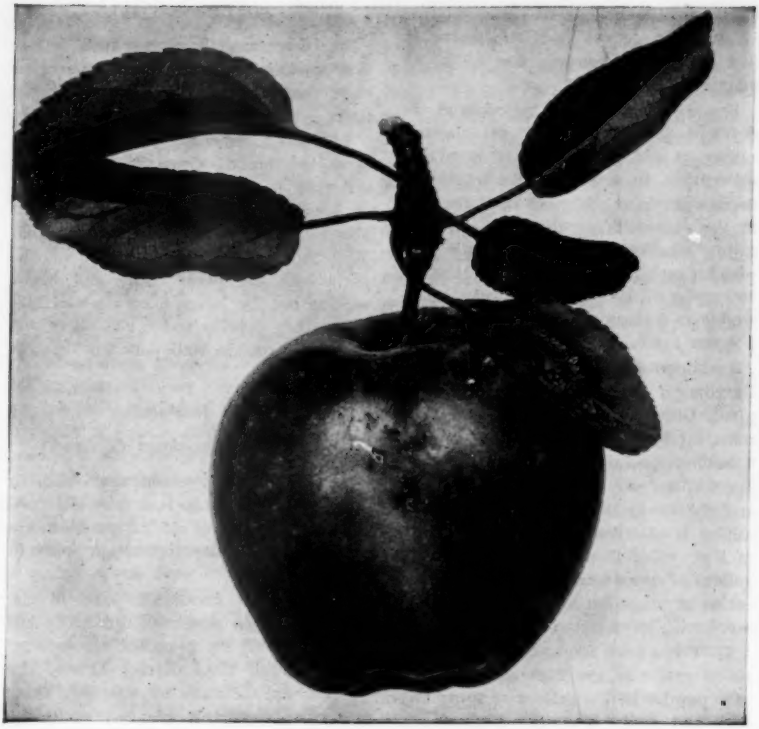
(*Spilonota ocellana* Denis & Schiffermüller)

The bud moth is frequently present in New York orchards. Although it is less often an important pest in eastern New York, it has frequently caused serious injury in western New York orchards along Lake Ontario.

The insects pass the winter as small, half-grown larvae in inconspicuous silken cocoons covered with bits of bark and frass and fastened in the crotches of the twigs and around the buds of the smaller branches. The larvae emerge early in the spring, burrow into the opening fruit buds, and web together the unfolding leaves which soon turn brown. They also gnaw into newly formed fruits causing an injury similar to that produced by the leaf roller.

The larvae sometimes bore into the terminal shoots, causing the tips to die back.

The larvae, which are chocolate brown with head and cervical shield black, become full-grown in late May or June and pupate within the nests. The small, ash-gray moths, with white markings, are present in the orchard from the middle of June until August. Soon after emerging, the female moths deposit singly on the leaves their milky white, flat, disk-like eggs. These hatch in about a week, and the young larvae feed on the underside of the leaves, during July and August, skeletonizing them in patches along the midrib and the larger veins and covering their feeding ground with a web of silk. Often,



Photograph from S. W. Harman

FIGURE 9. FRUIT INJURED BY THE SUMMER BROOD OF BUD-MOTH LARVAE

where an infested leaf rests against the surface of an apple, the larvae will eat out a group of small cavities, resembling codling-moth "stings" in the surface of the fruit (figure 9). In badly infested orchards a large proportion of the crop may be injured in this manner.

In September the half-grown larvae desert the leaves and crawl to the branches, where they form their winter cocoons.

Control

The control of bud moth depends on thorough application of the recommended control measures.

DN materials applied while the buds are still dormant are one of the most effective ways to control bud moth. For ordinary infestations, 3 quarts of DNC liquid or 3 pounds of powder are enough (page 6). At this strength, aphids and moderate infestations of oystershell scale also are controlled. In severe bud-moth infestations, you may need to increase the dosage to 4 quarts or 4 pounds of DNC.

Fall applications are as effective as spring applications, but for greatest safety make them after the leaves drop from the trees. DNBP used at the rate of 2

quarts in 100 gallons of spray mixture gives control equal to DNC slurry or powder. Do not, however, use the DNBP materials in the fall.

If you do not use DN materials in the dormant period, you may use nicotine sulfate at the green-tip or delayed-dormant stage. In most years the nicotine is more effective at the green-tip stage than at the delayed-dormant period. Nicotine sulfate usually is used at the rate of 1 pint for each 100 gallons of spray mixture. In heavily infested orchards, it may be desirable to increase the nicotine sulfate to 1 quart for each 100 gallons of water.

Parathion is effective at this time but the danger of increasing apple scab is great. Greening and Duchess, may show some injury.

In heavily infested orchards, summer applications may also be needed to control the young larvae on the leaves. Parathion is effective when used at the rate of 1 pound of 15 per cent powder in 100 gallons of spray mixture. Make the application any time during the period of summer-brood larval activity.

DDT has been found to be effective if timed properly. Use 2 pounds of 50 per cent powder in 100 gallons of spray mixture and apply it at the beginning of hatch and again about ten days later. Lead arsenate is also effective when used at the rate of 3 pounds in 100 gallons of spray in a single application at the beginning of hatch. For maximum effectiveness with all these measures, be sure to cover thoroughly the undersides of the foliage where the larvae are feeding. The choice of the material to use in summer sprays is guided by the presence of other pests and by the materials you used in previous sprays.

Reduce bud moth to as low a point as possible by early season treatments. If enough of the spring brood escape to threaten damage to the growing fruits, make a special effort to make the summer applications timely and thorough.

SCALE INSECTS

The three most important scale insects that attack the apple are the San José scale, the oystershell scale, and the scurfy scale.

The insect under the scale is a degenerate, soft-bodied creature. The young scale insects, for a short time after birth or hatching, as the case may be, move about in search of a suitable place to feed. They then insert their thread-like mouthparts into the plant tissue and begin sucking out the juices. Soon after settling down, they develop scales, and all except the males remain stationary for the rest of their lives.

San José scale

(*Aspidiotus perniciosus* Comstock)

San José scale is seldom a problem in well-sprayed orchards. It is most often observed in the tops of old, high trees where it is difficult to deposit enough spray in windy weather.

These scales attack all parts of the tree and, when numerous, gradually kill the limbs and the branches. On infested fruit, reddish rings develop around the spots where the scales are attached. These are more commonly grouped about the blossom end.

The scale of the full-grown female is round, about the size of a pinhead, and grayish in color with a central dark spot. In bad infestations these scales are crowded together and resemble a grayish, roughened, scurfy deposit on the bark. The scales of the young insects are smaller than those of the adult, and are black.

Although the insects are present in all stages on the trees in the fall, all perish during the winter except a small proportion of the partly grown young. These complete their development in the spring, and the mature females begin to give birth to living young in the latter part of June. In a cool season with a late spring, the scale does not begin to breed until

late, and under these conditions only one full brood and a partial second brood are able to develop before cold weather. Each female gives birth to between 100 and 200 young.

Control

In many orchards it is not necessary to make special applications each year to control San José scale. The scale is, however, a constant menace and should be watched closely. The most efficient treatment for San José scale is a dormant-type oil emulsion containing 2 per cent of oil (page 7). For best results, apply this spray in the dormant, green-tip, or delayed-dormant stage. You can make the cheapest spray for this purpose by using in the spray tank 2 gallons of dormant oil and ½ pound of commercial blood albumen or a 2–4–100 bordeaux mixture as an emulsifier. Commercial dormant-oil emulsions may also be used.

If for any reason, you do not wish to use an oil spray, San José scale can be controlled by spraying in the dormant period with 2 quarts of DNBP and water to make 100 gallons. In the past, 11 gallons of lime-sulfur and water to make 100 gallons have been used through the green-tip stage. Two applications of DDT at the calyx and curculio sprays will control the pest.

Oystershell scale

(Lepidosaphes ulmi Linnaeus)

The oystershell scale usually is of no importance in well-sprayed commercial orchards. It is more likely to be troublesome in the cooler climate of the northern counties of the State. The mature female scale is about ⅛ inch long and closely resembles an oystershell in form. This species winters over in the egg stage beneath the old scales, and the young hatch in May or June.

Control

The oystershell scale is rarely present in injurious numbers in well-sprayed orchards. You may control it by spraying with one of the DN materials. Most infestations are easily controlled with 3 quarts of liquid DNC or 3 pounds of powder. In severe infestations it may be advisable to increase the concentration to 4 quarts of liquid or 4 pounds of powder in 100 gallons of spray mixture.

DNBP may be used at the rate of from 3 to 4 quarts in 100 gallons of spray mixture during the dormant period. As with the San José scale, DDT is useful in the calyx and curculio sprays at a rate of 2 pounds of 50 per cent powder in 100 gallons of spray mixture.

Scurfy scale

(Chionaspis furfura Fitch)

In recent years, orchards in restricted areas on both sides of the Hudson River have become heavily infested with the scurfy scale. The full-grown female scale is about ⅛ inch long, and is flat, pear-shaped, and grayish white in color (figure 10). There are two generations of the insect annually. When the insects are numerous, they give the bark a scurfy appearance and in many cases the fruit is spotted in a manner similar to that caused by San José scale.

Control

Scurfy scale is best controlled by the use of an oil spray in the dormant or delayed dormant period. Use a "superior" dormant-type oil at a concentration of 3 per cent DDT applied in the calyx and the curculio sprays helps to suppress this insect when used in the same amounts as for the control of San José and oystershell scale.

FRUIT TREE LEAF ROLLER

(Archips argyrospila Walker)

Although present in small numbers in many New York orchards, outbreaks of the fruit tree leaf roller are destructive in only a few.

Photograph from O. H. Hammer

FIGURE 10. SCURFY SCALE ON APPLE TWIG

One scale has been turned back to show the eggs (greatly enlarged)

This insect passes the winter in the egg stage. The eggs are usually laid on the smaller twigs and on the fruit spurs, in small, oval, flat, grayish or brownish patches, about ¼ inch in diameter and containing an average of about 65 eggs.

The eggs normally start hatching when the blossom buds of McIntosh apples are showing pink, and continue to hatch over a period of about one week or longer depending on the season. The young caterpillars are about $^{1}/_{16}$ inch in length, and are of a light green color with the head and the cervical shield black.

The caterpillars cause a "ragging" of the leaves at the tip of the terminal shoots. As the young fruit is forming, the caterpillars eat out large, irregular holes in the fruit. The most seriously injured fruits soon drop, while those less severely injured remain on the tree but bear large, brownish, corky scars which render them misshapen and unmarketable.

The caterpillars become full-grown in from three to six weeks and are then about 1 inch in length. They transform to brown pupae within a rolled leaf, and in about twelve days emerge as moths. The moths have a wing expanse of ¾ to 1 inch, and the front wings are mottled with various shades of rich brown and yellowish white.

The moths begin egg-laying soon after emergence, and most of the eggs are laid by the last of June. The eggs do not hatch, however, until the following spring, and so there is only one brood each year.

Control

Oil sprays are effective against leaf-roller eggs. You may use "superior" dormant-type oils at a 3 per cent concentration in either the green-tip or delayed-dormant stages without injury.

If the oil spray is not used or if it is not enough to provide the desired control, a DDT spray may be used in the calyx spray at a rate of 2 pounds of 50 per cent powder in 100 gallons of water. This application is also effective against red bug.

RED-BANDED LEAF ROLLER

(*Argyrotaenia velutinana* Walker)

The insects overwinter as pupae beneath leaves and other débris on the ground, and these change to moths as the buds are bursting in the spring. The moths deposit their eggs during May on the trunk and larger limbs of the trees. The egg masses closely resemble those of the fruit tree leaf roller except that they are flatter and more irregular in outline. The eggs begin to hatch about the time the petals are falling.

The larvae are pale green in color with a straw-colored head as compared with the fruit tree leaf roller which is about the same color but has a black head. The larvae first feed on the underside of the leaves along the midrib and larger veins. Some of them may later attack the fruit, causing an injury similar to fruit-tree-leaf-roller feeding. Feeding continues during most of the month of June.

A second brood appears during August, and feeding may continue until the apples are harvested. They first produce feeding areas along the midrib on the lower surface of the leaves. They may then attack the fruit or confine their activity to skelontonizing the leaves.

The worms eat shallow irregular channels beneath the fruit surface. The worm itself is sometimes present at harvest time, rapidly wriggling off the fruit when disturbed. The second-brood larvae change to pupae and spend the winter beneath leaves and débris on the ground.

Control

Arsenate of lead, at the rate of 3 pounds to 100 gallons of spray mixture, has effectively controlled the relatively low population of this pest in orchards in the past. The widespread occurrence and severity of leaf-roller infestations in recent years has, however, made it necessary to develop more effective control measures.

Satisfactory control is obtained only when you apply spray to cover the underside of the leaves where the larvae feed. Thoroughly spray all trees in the orchard, bearing and non-bearing. Experience indicates that second-brood control measures are probably of more value than first-brood measures.

The most effective control measure for red-banded leaf roller in both the first and second broods is DDD, sometimes called *TDE*. It is used at the rate of 1 pound of the 50 per cent powder in 100 gallons of spray in either the petal-fall or 10-day spray (preferably) for first-brood control and at the rate of 1½ to 2 pounds in an early August spray for the second brood. The lower dosage of 1½ pounds is used where the leaf roller alone is a problem and the 2 pound rate is used where protection against codling moth or apple maggot is desired in the same spray. In the first brood spray, DDD is ineffective against all other insects present at that time and must be added to other materials with the exception of parathion.

Parathion may be used in two sprays, petal-fall and 10 days after petal-fall, at the rate of 1 pound of the 15 per cent powder with results approaching those of DDD. It may also be used at the rate of 1½ pounds in the early August spray on non-McIntosh varieties and will protect against all insects present at that time with the exception of apple maggot.

In timing the August spray, the most efficient point is when approximately 75 per cent of the larvae have hatched. This point is usually reached about August 1 in eastern New York and August 8 in western New York. A follow-up spray may be needed from 10 to 15 days after the first if adequate under-the-leaf coverage was not possible in the first spray.

In the 1953 season, many growers using air-blast machines in both dilute and concentrate applications failed to get control with a single early August spray with DDD. Since this material apparently kills the larvae by making them unable to feed, it may take from 10 to 15 days before the effect of the spray is noticeable. An examination of the undersides of the leaves after this period should determine whether a second application is necessary or not. The second treatment if needed should be made prior to September 1 since the larvae may move to the fruit after that time.

GREEN FRUITWORMS

Grapholitha grotei Riley
Orthosia hibisci Guénée
Lithophane antennata Walker
Grapholitha laticinerea Grote

Green fruitworms are rather large apple-green sluggish caterpillars with a narrow cream-colored stripe down the middle of the back, with a wider stripe along each side, and between the two an indistinct stripe is often present. Outbreaks in New York have occurred in 1877, 1896, 1913, and 1933.

The moths of the green fruitworms appear on the trees in March or April and deposit their eggs singly on the bark of the smaller branches. The young larvae feed on foliage or opening buds and are about half-grown by the time the fruit is set. The fruit scars caused by the green fruitworms are similar to those of the leaf roller but usually are not so deep. Most of the caterpillars become full-grown by the first week in June. They then go into the ground for pupation. There is only one generation a year.

Control

The green fruit worm is not so difficult to control as is the fruit tree leaf roller. Thorough spraying in the pre-blossom and petal-fall applications with 2 pounds of 50 per cent wettable powder or 3 pounds of lead arsenate in 100 gallons of water holds the pest under control. Whenever possible use the petal-fall application in place of the pre-blossom spray.

EASTERN TENT CATERPILLAR

(Malacosoma americanum Fabricius)

Although in years of abundance the eastern tent caterpillars may defoliate neglected and unsprayed apple and peach trees, they are seldom of importance in well-sprayed orchards.

Control

The caterpillars hatch as the buds are opening. DDT at the rate of 2 pounds of 50 per cent wettable powder or 3 pounds of lead arsenate in 100 gallons of the spray mixture, included in the delayed-dormant spray, gives excellent control.

EUROPEAN RED MITE

(Paratetranychus pilosus Canestrini and Fanzago)

The European red mite passes the winter in the egg stage on the under surface of small branches of trees, in crevices and crotches of fruit spurs, and on roughened areas on the bark of the larger limbs and the trunk. The eggs are small, spherical, and reddish in color, and when numerous they resemble a coating of brick dust. Usually, they begin to hatch when the blossom buds first show pink, and have completed hatching by the time the petals have fallen. The newly hatched mites crawl to the leaves and begin to feed mainly on the underside of the leaves. Seven or more generations may follow in rapid succession until the vitality of the leaves may be greatly lowered. The mites then move on to more succulent leaves, abandoning those first infested.

The period from the date of hatch until the first adult appears is about two weeks and extends from the pink to the petal-fall stages. Usually, injury can first be seen on fruit spurs near the center of the tree. The leaves of the blossom cluster are generally the first to show the grayish green or brown color commonly called "bronzing." Injury by red mite consists of brown foliage, leaf drop, and small fruit with poor color. Severe infestations early in the season have been shown to influence the set of fruit for the following year. Infestations building up in late August and September are not believed to cause serious damage although excessive pre-harvest drop has been known to occur where foliage is seriously injured prior to harvest.

Certain varieties are more seriously injured than others. These highly susceptible kinds include Red Delicious, Baldwin, Yellow Transparent, and Early McIntosh.

Control

European red mite is best controlled by dormant-type oil sprays that kill the

overwintering eggs. If you use DDT in the spray schedule, a dormant-type oil at this time or some other early treatment is required. Best results are obtained when this application is made in the green-tip or delayed-dormant stage. A 2 per cent concentration of "superior" dormant-type oil should be used. The use of oils at this time does not completely eliminate the possibility of a summer build-up. It does, however, greatly reduce this possibility, and delays such a build-up for from two to six weeks, if it occurs at all.

As an early season replacement for oil on a trial basis you may use Ovotran or Orthotran. Make the first treatment at the pink stage at the rate of ¼ pound of 50 per cent powder. Apply subsequent sprays at the rate of ½ pound of powder in the ten-day spray, the second cover and the fourth cover. This program also affords protection against early two-spotted mite damage.

Make summer applications when an average of from four to six mites can be found on each leaf in June, July, or early August. It is almost useless to spray after the leaves of the tree have been completely bronzed. Because the mites are present on both sides of the leaves, thoroughly cover both sides of the leaves with spray.

TEPP is one of the more widely used materials available at present for summer control of red mite. Use TEPP at the rate of ¼ to ½ pint in 100 gallons of spray mixture. Make two applications at an interval of from seven to ten days. During periods of warm to hot weather, the shorter intervals of from seven to eight days may be used for maximum effectiveness. During cooler weather, the longer intervals of from nine to ten days will be effective. You may also include parathion in the spray mixture at the rate of 1 pound of 15 per cent powder and water to make 100 gallons of spray. This material helps to control a number of insects as well as mites, whereas TEPP gives protection only against mites and aphids. Two applications are necessary. It is unsafe to use the 1-pound dosage of parathion on McIntosh, Cortland, and other McIntosh crosses because of the danger of injury to the fruit. The dosage recommended for mite control is effective against green aphids but is not enough to control codling moth or red-banded leaf roller. If you wish a combination measure for mites, codling moth, green aphid, and apple maggot, for example, do not use parathion alone because parathion apparently has little effect on apple maggot under orchard conditions.

During the past season, a combination of ½ pound parathion and 1½ pounds DDT was used in many orchards. This gave excellent protection against codling moth and was adequate for mite control.

In case resistance to phosphorous-containing materials becomes a problem, you may substitute or alternate other miticides, such as EPN malathion, aramite, dimite, or sulphenone.

TEPP should not be combined with lime, bordeaux, or other alkaline materials as the miticidal efficiency is greatly reduced by such combinations.

TWO-SPOTTED MITE

(Tetranychus bimaculatus Harvey)

The winter form of the two-spotted mite is bright orange in color and hibernates on the trunks of fruit trees and beneath trash on the ground. As the temperatures rises in the spring, the surviving adult females begin egg laying, both on the tree and on various types of plants found beneath the trees, such as bindweed, clover, and many other plants. These eggs are pale green or colorless. These first eggs may take from one week to a month to hatch, depending on the temperatures. The mites feed primarily on the undersides of the leaves. The summer form of the adult female is pale yellow or greenish in color and has two prominent dark spots on the back or dorsal surface.

In late summer this mite begins to build

up rapidly on fruit trees. At this time of the year a generation of mites will be completed in an average of from eight to ten days. In severe infestations, the feeding of the mites results in pale or whitish foliage. The presence of this pest can often be detected by the fine silvery webbing which is found on twigs and branches where high populations are active. The activity of this species may continue until harvest time or later. To more readily distinguish the two-spotted mite from the European red mite, refer to table 2.

Control

The appearance of the two-spotted mite as an orchard pest seems to be closely associated with the use of DDT. No effective dormant control measure is known. Attempts have been made to place rings of tanglefoot around the trunks of trees to prevent the mites from migrating up the trunks of the trees, without success. Apparently the mites are able to travel for some distance on the wind and to reinfest trees in this manner, although the principal means of migration is probably directly up the trunk.

Control measures should be used in the summer when the mite population approaches an average of from 4 to 6 mites on each leaf. A common mistake is to wait too late to apply control measures. The two-spotted mites are found chiefly on the lower surface of the leaves. To control these pests, apply both sprays and dusts to cover completely this side of the foliage. Use the same materials as those discussed under European red mite (page 34) with the exception of dormant oil.

CODLING MOTH

(Carpocapsa pomonella Linnaeus)

The codling moth is, year after year, the most serious pest of apples in New York. Not only does it cause practically all of the familiar wormy apples which are almost a total loss to the grower, but it also produces serious damage in the form of "stings," or small shallow cavities, which throw affected apples out of the better grades.

The insects pass the winter as full-grown larvae in tough silk cocoons lining small cavities beneath flakes of bark on the tree, in crotches, crevices, and pruning scars on the trunk, and in dead, punky

TABLE 2. Distinguishing Characteristics of Two-spotted Mite and European Red Mite

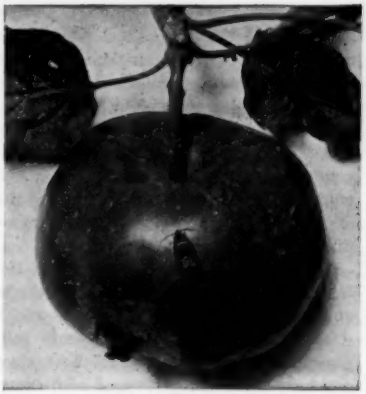
Characteristics	*European red mite*	*Two-spotted mite*
Overwintering form	Egg	Adult female
Adult female	Dark red, prominent bristles	Pale yellow or greenish with two prominent spots
Summer egg	Orange or red	Pale or colorless
Host plant	Apple, plum, prune, peach, pear, cherry	Broad-leaved weeds, Bindweed, and the like, as well as apple, plum, prune, peach, pear, and cherry
Peak of population	Generally during June, July, August	Generally during August and September
Webbing	No webbing produced	Fine silvery webbing produced, conspicuous in very heavy infestations

twigs, sticks, and débris on the ground. Numbers of the larvae overwinter in crevices in the floor, the siding, and the bins of packing houses, cider mills, or other places where apples have been stored at picking time. The larvae are pinkish or whitish in color, and about ¾ inch in length when full-grown. With the advent of warm weather in the spring, the larvae transform inside their cocoons to brownish pupae ½ inch long. They remain in this stage from three to four weeks and then change to moths. The moths have a wing spread of about ¾ inch. The front wings are marked near the tip with a coppery brown spot bounded on the inside by a chocolate-colored band (figure 11). The moths are active mainly throughout the twilight period on warm evenings. They are not strong flyers, the majority settling down within from 200 to 300 feet of the place of emergence.

The emergence of first-brood moths extends over a period of about 6 or 7 weeks, beginning shortly after the petals have fallen and reaching a peak about four weeks later. Some of the moths from buildings and packing houses may emerge from one to three weeks later than does the brood in the orchard.

The female moth deposits her flat, disk-shaped, scale-like eggs on the leaves and on the surface of the fruit. The eggs are smaller than a pinhead, are whitish in color, and are almost transparent at first but later show a reddish ring, and, just before hatching, a black spot, which is the head of the larva.

Temperature and weather conditions have a very important effect on egg-laying. Warm, dry seasons seem to be especially favorable for the development of the pest. The moths are active in egg-laying only on clear evenings when the temperature ranges above 60° F. If the weather is favorable, the moths begin to lay eggs within 3 or 4 days after emergence. With continued favorable weather, egg-laying starts about 1 week after the petals have



Photograph from S. W. Harman

FIGURE 11. CODLING MOTH: WORM HOLE ON LEFT, MOTH IN CENTER, AND "STING" ON RIGHT

fallen and is heaviest about 4 weeks later, or soon after the maximum emergence of moths. Periods of cool or stormy weather may delay the start of egg-laying or interrupt it for a time, so that the egg-laying and egg-hatching periods may be irregular in some years.

The time required for the eggs to hatch depends somewhat upon the temperature, but it averages about a week. The newly hatched caterpillars are about $^1/_{16}$ inch in length.

Many of the early hatched caterpillars of the first brood enter through the calyx cup, or blossom end, of the fruit. If they are not killed by insecticides in the calyx cup, they eat their way to the core. This point is extremely important where lead arsenate schedules are used, but not so important with DDT schedules. Most of the later-hatched caterpillars enter the fruit through the side. They prefer to enter either where an apple touches another fruit or a leaf, or where an insect injury, a puncture, or a russeted area makes entrance easier. Many of these "side-worm" caterpillars cause a type of injury known

as *codling-moth stings* (figure 11). A sting results when a larva, after having eaten out a shallow cavity under the skin, either finds the food unpalatable and deserts the burrow to try another point of entrance, or dies from the effect of the insecticide that it has obtained while making an entrance. A few of the first-brood larvae, entering the side of the fruit late, find the apple sufficiently developed, and burrow directly to the core (figure 11).

The time spent by the larvae in the fruit varies considerably, but averages about 30 days for the first brood and 3 weeks for the second. When nearly full-grown, the larvae burrow to the surface and keep the opening plugged with excrement until they are ready to leave the fruit. The full-grown larva is about ¾ inch in length, and is pinkish white in color with the head dark brown and the thoracic and anal shields lighter brown.

The greater number of the first-brood larvae leave the fruit before it falls, and crawl down the branches until they find a suitable place for spinning a cocoon. A considerable proportion of the larvae from fallen fruit spin their cocoons in sticks and débris on the ground. After making the cocoons, the larvae may do one of two things; they may remain in the larval condition until the following spring, or they may change to pupae in about a week. In the latter case the summer pupae transform in about ten days to a brood of moths that lay eggs for the second generation.

In New York, only some of the larvae spinning cocoons before August 1 transform to form a second brood in the same season, and practically all the larvae that become mature after that date hibernate. The second brood is usually smaller than the first. A larger proportion of second-brood caterpillars enter the fruit at the side than do the first brood, and most of these burrow directly to the core. Only a small proportion of them cause shallow stings like those made by the first brood.

Control

Apply the first spray for the control of codling moth when the last of the petals are falling. Insecticides applied at this time are retained in the calyx cavity and kill codling-moth larvae attempting to enter this point in the fruit later in the season. You may use either 2 pounds of 50 per cent wettable DDT powder or 3 pounds of lead arsenate in 100 gallons of water. If either red bug or fruit tree leaf roller or both are also a problem, DDT is preferred in this application.

The remaining sprays used for the control of codling moth are called *cover sprays*. The object of the cover sprays is to keep the fruit covered with the insecticide throughout the period when moths, eggs, and larvae are present, to prevent injury to the fruit. The cover sprays must be applied thoroughly as well as at the right time. If the fruit and foliage are thoroughly covered, many of the caterpillars hatching on the leaves will be killed before they are able to reach the fruit.

Make a special effort to check the first brood. Many failures in codling-moth control are the result of spraying one side with the wind and then waiting for the wind to change before covering the other side. Another common cause of failure results from inadequate coverage in the top-center of the tree. Thorough spraying year after year reduces the number of moths in an orchard. For this reason, thoroughly spray even light crops of fruit and do not allow them to become wormy. Odd trees near the orchard should also be sprayed. The screening of near-by packing sheds, prop poles, or apple storages helps to control codling moth. Moths from such locations may emerge and infest the orchard.

Since the timing of the cover sprays varies each year depending on the season, reliable information on the seasonal development of the codling moth is important. In most of the counties where

fruit is grown extensively, this information can be obtained through the county agricultural Extension spray-information service. The materials used for the control of codling moth in the cover sprays varies with the severity of the infestation.

DDT has proved to be the most effective control measure available for codling moth. Where codling moth is a serious problem, use a wettable DDT powder at a rate to make 2 pounds of 50 per cent wettable powder in 100 gallons of water. From three to four cover sprays applied at 10- to 14-day intervals are needed to control the first-brood worms. One or two applications may be necessary for second-brood control. Apply these sprays when worm activity begins in late July and early August. If more than one second-brood DDT spray is to be used, reduce the amount of DDT in each spray from 2 pounds of 50 per cent wettable powder to 1 pound in 100 gallons of spray. No DDT applications should be applied within 2 weeks of harvest, and a 3-week interval or more is preferable to prevent both toxic and visible residues. Use no more than four or five cover sprays at the recommended dosage because of the danger of exceeding the tolerance on toxic residue at harvest time. At present there is no practical way to remove excessive DDT residues from the fruit.

Where codling moth has not been a problem, a program using 3 pounds of lead arsenate alone in 100 gallons of water may be followed. This program is less likely to accentuate other insect and mite problems. Usually three sprays at fourteen-day intervals are enough to provide good control. Lead arsenate should not be used in more than four cover sprays or in the second-brood sprays because of excessive residues of both lead and arsenate.

Parathion may be used in one or more applications at a dosage of 1½ pounds of 15 per cent powder in 100 gallons of spray mixture. This treatment also helps to control orchard mites, green aphid, red-banded leaf roller, and summer brood bud moth if timed properly. Parathion apparently does not remain on the trees at this concentration in a form toxic to the codling moth for longer than ten days under average conditions. In a number of instances in which parathion has been under test as a complete schedule, it has not been too effective at the end of the season in comparison with DDT. At present, parathion should not be used within 14 days of harvest. It would seem advisable, therefore, to use parathion in only one or two sprays where desirable. Parathion should not be used on McIntosh, Cortland, and other varieties of McIntosh parentage at the above concentration because of danger of injury to the fruit. You may use DDD as a substitute for DDT where necessary for red-banded leaf roller control without seriously reducing the efficiency of the codling-moth program.

APPLE RED BUGS

Apple Red Bug (*Lygidea mendax* Reuter)
Dark Apple Red Bug (*Heterocordylus malinus* Reuter)

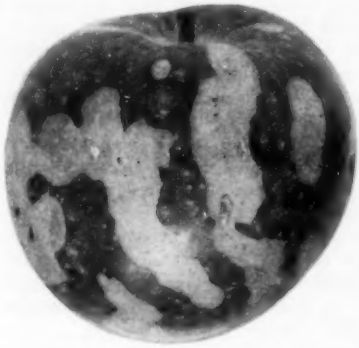
Red bugs have been important pests of the apple throughout New York State but infestations have diminished since the introduction of DDT. The infestation is seldom general in any fruit district; it is usually confined to occasional orchards or to certain varieties of apples.

Practically all of the serious commercial damage is caused by the apple red bug. Both species pass the winter in the egg stage in the bark of the smaller branches of apple trees. The eggs of the apple red bug begin to hatch when the earliest blossoms show pink, and continue hatching through the blossoming period.

The newly hatched nymphs, which are $^1/_{16}$ inch in length and bright red in color, at once attack the tender young leaves of terminal shoots and the new growth on lateral shoots and spurs. The youngest tender leaves soon develop clusters of conspicuous reddish dots marking the feed-

ing punctures of the nymphs. These injured tips are often the first indication of the presence of red bugs in an orchard. The insects themselves are very wary and difficult to detect among the unfolding leaves. The nymphs may live on the foliage until they are full-grown, but usually leave the shoots to attack the fruit soon after it has set. When very young fruit is attacked, the bristles of the bugs penetrate to the core. Many of the injured fruits may fall to the ground. Those that remain becomes gnarly and deformed (figure 12). Punctures made later, after the fruit has become too large for the insect to reach the core, may develop either into shallow pits or into peculiar irregular, russeted areas (figure 13). The adults deposit their eggs during June or July and these do not hatch until the following spring.

FIGURE 12. AN APPLE INJURED BY FEEDING OF RED BUG



Photograph from P. J. Chapman

FIGURE 13. ANOTHER TYPE OF INJURY TO APPLES BY FEEDING OF RED BUG

Control

The most practical way to control red bugs is the use of DDT in the petal-fall spray, at the rate of 2 pounds of 50 per cent wettable DDT in 100 gallons of spray.

THREE RUST DISEASES OF THE APPLE

Apple Rust *(Gymnosporangium juniperi-virginianae* Schweinitz)

Hawthorn Rust *(Gymnosporangium globosum* Farlow)

Quince Rust *(Gymnosporangium germinale* (Schweinitz) Kern)

The three rust diseases of apple are caused by three fungi that live during a part of their lives on the red cedar and during the remainder largely on the apple, the hawthorn, and the quince, respectively.

Both the apple and the quince rust cause direct and serious losses by infections on the apple fruit, while the apple and the hawthorn rust are occasionally destructive on apple foliage. Both types of injury have been largely confined to eastern New York, where red cedars are abundant. The bright orange-colored spots of the apple and hawthorn rusts on the apple leaves are conspicuous; the hawthorn-rust spots are somewhat the smaller.

The apple-rust spots on the fruit are orange in color, and the small cups of the apple-rust fungus may be seen on the spots when mature. The quince-rust spots on the apple fruit are sunken and are dark green in color, and the tissue below the spots is killed. The small cups of the rust fungus are absent in fruit affected with the quince rust.

The apple rust and the hawthorn rust form their fruiting bodies on the red cedar in the form of cedar apples. These apples, or galls, of the two rusts are similar in appearance, but those of the apple rust are more regular in outline than those of the hawthorn rust, and the surface is covered with circular depressions much like those on a golf ball; the apples of the hawthorn rust are more irregular in form, and do not show the regular arrangement of circular depressions. When the cedar apples are wet in the spring, yellow gelatinous horns protrude from them, these are long and tapering in the apple rust and shorter and more wedge-shaped in the hawthorn rust. The quince rust does not form the galls, or cedar apples, on the cedar, but fruits in cankers on the twigs, the limbs, or the trunk.

The most important of these rusts on apple in the Hudson Valley is the quince rust, for it may cause serious loss of fruit in such apple varieties as McIntosh, Red Delicious, Cortland, and Rome. More than 20 varieties of apples may be infected with quince rust.

Apple rust has been long recognized as a serious disease of apple leaves and fruits, especially on the more susceptible varieties such as Wealthy, Jonathan, Winter Banana, and Rome. In the Hudson Valley it is much less important economically than is quince rust. The quince rust matures later than the more conspicuous cedar apple of the apple rust. At first the teliospores of the quince rust expand little when wet and do not germinate, but after one to three weeks they expand fully into cushioned-shaped gelatinous masses and shoot an abundance of basidiospores. After swelling three or four times during wet periods, the telia lose their cushion shape and deep red color and become shapeless yellowish red masses. After from six to eight gelatinizations the telia drop off. Apple-fruit infection by quince rust occurs only during a brief period, from the time the blossoms begin to open through the bloom period. After the petals drop, the fruits are no longer subject to infection by quince rust.

Control

You can effectively control cedar rust by the eradication of all red-cedar trees within a radius of at least one-half mile from your orchard. One red cedar tree heavily infected with cedar galls is enough to infect an average-sized orchard. In most situations in the Hudson Valley cedar eradication seems impractical.

The application of fungicides is the most promising alternative.

To control apple rust on leaves and fruit, protective sprays are required from the time the young leaves emerge from the buds. Fruits are no longer suscepible to apple rust a few days after petal fall, but leaf infection may occur on young leaves through June. Quince-rust control is obtained from the pink and bloom applications. An organic compound, ferric dimethyldithiocarbamate (ferbam) in Hudson Valley experiments was much more efficient than sulfur in the control of all three cedar rusts. If the rusts are serious on apple, use ½ pound of the ferbam with 3 pounds of elemental sulfur in 100 gallons of spray in the pre-bloom and bloom spray to control quince rust and also in the petal-fall and curculio spray to control apple rust where it is serious.

Most of the other organic fungicides used for scab control, such as the mercuries, captan, glyodin, and Phygon, as well as sulfur, are less effective in rust control than is ferbam. The dithane compounds are effective in controlling the rusts. Combinations of ½ pound of ferbam with sulfur or with other organic fungicides have given commercial control of the rusts.

Little recent work has been done on the control of the rusts on the cedar. Earlier work (1937) indicated that four sulfur sprays, applied at 3- to 4-week intervals starting in mid-July, would practically

control apple rust on red cedars. To control quince rust on cedars apply a series of sulfur sprays at 3- to 4-week intervals, with the first spray in late May and continuing until September. No reports have been made of the use of ferbam to control rust on the cedars. The ferbam–sulfur mixture used on apples should be tried. The quince-rust galls are perennial on the cedar, while apple rust and hawthorn rust "cedar apples" are ordinarily annual.

Hawthorn rust is the least important of the three rusts of cedar on apple. It attacks only the apple leaves, and the spray program to control apple rust on apples also controls hawthorn rust. Fruiting rust lesions on McIntosh leaves are invariably hawthorn rust. The development of aecia of hawthorn rust on apple leaves is later than for the apple rust, and sprays on cedars from August 1 on controls hawthorn rust on cedar.

BLACK ROT

(Caused by the fungus *Physalospora obtusa* (Schw.) Cooke)

Black rot attacks the bark and the leaves of the apple, as well as the fruit. On the bark the disease is called *black-rot canker* and *New York apple-tree canker*. On the fruit it is called *black rot*, *blossom-end rot*, and *brown rot*. On the foliage it is usually called *frog-eye*, although it is known also as *leaf-spot* and *brown rot*.

This disease is of more importance economically as a leaf-spot and as a canker than as a rot of the fruit. In this State, the varieties Baldwin, Rhode Island Greening, and Twenty Ounce show spotted foliage most commonly. Twenty Ounce is by far the most susceptible of all the varieties to the canker form, but Esopus Spitzenburg, Baldwin, Wagener, Rhode Island Greening, and Tompkins King also are susceptible to cankers.

In the Champlain Valley considerable black rot canker has developed in McIntosh trees which had previously suffered severe winter injury. No effective means of controlling black rot in these winter-injured trees has been discovered.

In severe attacks of "frog-eye," defoliation may occur before harvest; in slight attacks the loss is negligible.

Control

For leaf-spot, lime-sulfur is quite as effective as bordeaux mixture. Dusting with sulfur also is effective. Summer applications are effective against this disease, since most of the leaf infection is during the 2 or 3 weeks after the petals have fallen.

The effectiveness of applications of fungicides for canker prevention is not proved. The decided decrease of canker injury in the State after the general adoption of lime-sulfur spraying led to the belief that these applications were of value. Systematic cutting-out of cankers and removal of mummied fruit are valuable methods of control.

PLUM CURCULIO

(*Conotrachelus nenuphar* Herbst)

(See also under *Peach*, page 73)

In parts of the Hudson Valley the plum curculio is one of the most serious pests of the apple, because the numerous stone walls, hedgerows, and woodlots adjoining the orchards serve as ideal winter quarters for the beetles.

The apples are injured by the feeding and egg-laying punctures of the adults and by the burrowing of the grubs. Many of the injured apples fall to the ground, while those that remain on the tree develop D-shaped russeted scars (figure 14) and are often rendered knotty and unmarketable.

The overwintered beetles begin to attack the fruit soon after it has set, and are capable of causing extensive injury in a very short time. Although both feeding and egg-laying may continue for a considerable period, egg-laying is most intensive during the first few weeks after the fruit sets. It is during this period that

Photograph from P. J. Chapman

FIGURE 14. SCARS RESULTING FROM EGG-LAYING AND FEEDING PUNCTURES MADE BY THE PLUM CURCULIO

the grower usually wins or loses his fight against this pest. The new generation of beetles, appearing in August, sometimes injure the fruit by their feeding punctures before going into hibernation. Usually, however, this type of injury is not important in New York.

Control

Lead arsenate in the petal-fall, curculio, or special scab, and first cover sprays has been extensively used in the past where plum curculio is a problem. DDT is not effective in controlling plum curculio unless in combination with lead arsenate. Parathion, methoxychlor or dieldrin is suggested in orchards where trouble has been experienced in the past from this insect, as discussed on pages 11 and 12.

If the weather is warm soon after the petal-fall spray is applied, shorten the next application for curculio to a 7-day interval. The first cover spray for the codling moth, usually applied about 3 weeks after the petal-fall spray, is of value in controlling the curculio in eastern New York. Dieldrin is of little value in this spray for codling-moth control and should be combined with DDT. Curculio injury is often localized in certain parts of an orchard near hibernating shelter. In such cases the special sprays may be applied only to that part of the orchard where they are needed. Only the most thorough spraying of the trees, inside and out, insures good curculio control.

APPLE MAGGOT

(Rhagoletis pomonella Walsh)

In the eastern and central New York fruit-growing regions, the apple maggot, or railroad worm, is one of the most serious pests of the apple and is present in many orchards. All apple varieties may be attacked, but early harvest and early fall varieties are especially subject to injury. Of the later varieties, Fameuse, Jonathan, Northern Spy, and Red Delicious are the most liable to attack. The apple maggot occasionally infests plums and prunes.

The adult of the apple maggot is a black-bodied fly slightly smaller than the house fly (figure 15). The female is larger than the male, and has four white bands across the abdomen while the male has only three.

The flies begin to emerge from their overwintering puparia in the ground during the later half of June and continue to emerge until early August.

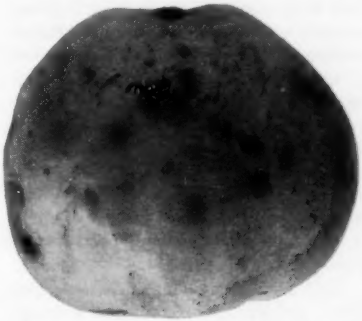


FIGURE 15. APPLE-MAGGOT FLY AND EGG-LAYING PUNCTURES

The flies do not begin to lay eggs until about 10 days after emergence.

The female deposits her minute whitish eggs singly, in the pulp of the apple. A large number of eggs may be deposited in a single fruit, and fruits of late varieties become much dimpled and pitted as a result.

The eggs hatch in from 4 to 6 days, and the young maggots begin at once to tunnel through the fruit, causing brownish trails. Often badly infested fruits fall to the ground early. The numerous tunnels reduce the inside of the fruit to a brownish, pulpy mass and render it unmarketable. Winter fruits in which eggs are laid late in the season may seem normal at picking time and later rot suddenly as a result of the work of the maggots after the fruit has begun to soften in common storage.

The full-grown maggot is about 3/8 inch long and whitish or yellowish white in color. It emerges from the fallen fruit and burrows into the soil to the depth of 1 or 2 inches. Here it changes to a puparium, in which stage it overwinters.

Control

You may use either lead arsenate or DDT to control apple maggot. Control is obtained by killing the flies before they can lay their eggs. If you use DDT, at least three applications are needed. These coincide with the second, third, and fourth codling-moth cover spray. In years of late fly emergence, or where flies migrate from adjoining unsprayed orchards or woodlots, a fourth DDT spray coinciding with the fifth codling-moth cover spray may be necessary. Use a wettable DDT powder at the rate of 2 pounds of 50 per cent wettable powder in 100 gallons of spray. A fungicide may be added to control apple scab.

Lead arsenate, although less toxic than DDT, provides protection for a longer time and may be used to control apple maggot. Apply the first spray shortly after the flies begin to emerge. In eastern New York this is usually about June 20. The flies tend to appear a few days later in western New York and in the Champlain area than in the Hudson Valley. For the more nearly accurate timing of apple-maggot sprays, large trap cages are used by the Extension Service spray-information service in certain counties to determine the daily emergence of flies from the ground. Apply the second lead-arsenate spray between July 12 and 18. Lead arsenate is used at the rate of 3 pounds in 100 gallons of water.

Parathion, TEPP, and nicotine sulfate are not effective against apple maggot.

It will often simplify the spraying program to cut down, or top-work, the occasional sweet-apple trees in commercial orchards, because these are seldom profitable and often constitute a real menace because of the apple maggots that they harbor. Neglected trees in hedgerows, in adjoining fields, and about farm buildings also are such a menace, and should likewise be cut down.

Thoroughly spray all trees in infested orchards. This applies not only to apple trees in their off-bearing year, but also to other fruits interplanted with apples. Failures to control the apple maggot are especially likely to result if spraying is confined to trees with fruit. Apply the maggot spray to neglected orchards and to scattered trees near and adjoining commercial plantings.

Arsenical dusts are effective against the flies, but additional applications are required if it rains. Usually three dusts are necessary to give protection equal to that of two sprays. From four to five applications of a 5 per cent dust have shown promise in controlling apple maggot.

ROSE LEAF BEETLE

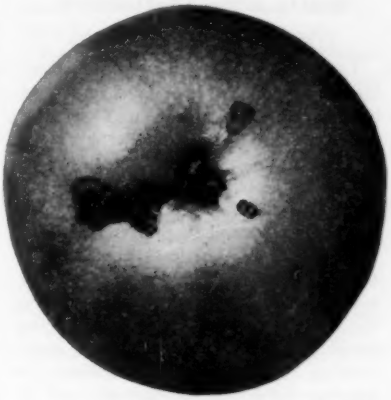
(Nodonota puncticollis Say)

In certain orchards in eastern New York, the rose leaf beetle has caused important losses. The beetle is about 1/4 inch in

length, bronzy green to bluish in color. The immature or grub stage of the pest feeds underground on the roots of a number of plants including: hop clover or yellow clover; cinquefoil or five finger; king devil; and devil's paint-brush or Grim the Collier. Limited observations indicate that orchards which adjoin fields in which these plants are growing are most likely to suffer injury from the feeding of the adult beetles.

The adults start emerging from the soil the latter part of May and feed preferably on the leaves and flowers of certain species of dogwood shrubs. They also feed on the leaves of blackberry, raspberry, and strawberry. From these they migrate to the orchard and may first be found feeding on the fruits about the first of June. The fruits most subject to injury include the apple, pear, and peach.

The beetles feed singly or in groups. As many as a dozen may be found feeding on a single fruit of apple, pear, or peach. They leave shallow, finely chiseled scars on apple and pear fruits, but deep wounds are also produced on the apple. Badly injured fruits drop prematurely but those less severely injured may reach maturity; they are, however, badly scarred and of little commercial value (figure 16).



Photograph from P. J. Chapman

FIGURE 16. APPLE INJURED BY THE ROSE LEAF BEETLE

Control

The rose leaf beetle can be controlled by spraying with 3 pounds of lead arsenate in 100 gallons of water. Apply the spray as soon as the beetles make their appearance on the trees which usually coincides with the curculio spray, about ten days after the petal-fall application. The second application is usually combined with the first codling-moth cover spray.

ROSE CHAFER

(Macrodactylus subspinosus Fabricius)

The rose chafer is an ungainly long-legged grayish brown beetle about ½ inch in length. The beetles invade the orchards, often in swarms, during the first or second week in June. They feed on the tender foliage and attack the young fruits. They eat out holes in the apples causing them to fall prematurely or to be so badly scarred as to be worthless.

Fortunately, the rose chafer is restricted as a pest to sandy regions. The larva of the chafer is a grub that feeds on the roots of grasses in sandy soil. The female beetle will not enter the heavier soils for egg laying nor do the grubs thrive under such conditions.

Control

You can prevent serious injury by the rose chafer by spraying with 2 pounds of 50 per cent DDT wettable powder in 100 gallons of the spray mixture. Make the application just as soon as the first beetles appear on the trees. The curculio or special scab spray, about 10 days after the petal-fall application, and the first codling-moth cover spray, about June 10 to 15, usually afford adequate protection from this pest if they are properly timed and thoroughly applied.

WHITE APPLE LEAFHOPPER

(Typhlocyba pomaria McAtee)

The white leafhopper is the most troublesome species of leafhopper attacking bearing apple trees in New York. The insect passes the winter in the egg stage on apple. The overwintering eggs are deposited in the bark, and hatch during the latter part of May. There are two generations, the second reaching maturity in September. The white leafhopper feeds on the underside of the leaves, causing a whitish stippling on the upper surface. In severe cases the spots coalesce, the leaves become blanched, and little green coloring matter is left. In addition to injuring the leaves, the second brood of hoppers may speckle the fruit with excrement, rendering it unsightly and lowering its market value. This is true especially of Rhode Island Greening and other light-colored varieties.

Control

You can readily kill leafhopper nymphs by spraying with 2 pounds of 50 per cent DDT wettable powder in 100 gallons of water.

Nicotine sulfate, ½ pint in 100 gallons of water in which 1 pound of soap flakes has been dissolved, is also effective. If the weather is cool, it is better to use ¾ pint of nicotine. This application should be made before the nymphs reach maturity, usually about the first week in August.

ROUNDHEADED APPLE TREE BORER

(Saperda candida Fabricius)

Most of the "borer injury" to apple trees is caused by the roundheaded apple tree borer. The adult is a large beetle, about ¾ inch in length, brown in color, and marked with two white stripes extending down the back. These beetles insert their eggs in the base of the apple tree near the ground level from mid-June to mid-August. The grubs or borers that hatch from these eggs are legless, cream colored with a brown head, and when mature may attain a length of about 1¾ inches. Their presence may be detected by the brown, sawdust-like castings which the borers push through the openings in the bark near the ground level. The borers usually remain in the trees for three years before completing their life cycle. Injured trees usually show a yellowing of the foliage and a general weakened condition but often maintain a healthy appearance and die suddenly before suitable remedial treatments can be applied.

Control

The most effective way to control the roundheaded apple tree borer is to kill the adult beetles before they can lay the eggs from which the grubs hatch. This is best accomplished by spraying young trees with the same schedule applied to bearing trees during June and July to control codling moth and apple maggot when a lead-arsenate program is employed. (See pages 14 to 16.) Use lead arsenate at a rate of 3 pounds in 100 gallons of water. Approximate dates for these applications are about June 10, 20, and 30 in the Hudson Valley and western New York, and June 15, 25, and July 5 in the Champlain Valley.

In commercial plantings, once the borers are in the trees, chemical injections into the borer tunnels in October are the most practical and effective means of control. Good control has been obtained with injections of the following chemicals: a mixture of 1 gram of paradichlorobenzene to 1 cubic centimeter of carbon disulfide (commercial preparations are available), a pyrethrum extract in alcohol base, and a 5 per cent rotenone extract in acetone. You can make the injection by using an ordinary oil can or grease gun. In small plantings you may cut out the borers in May with a knife.

A tree paint, consisting of 1½ pounds of calcium cyanide and 1 pint of raw lin-

seed oil, has been used by some growers with good results, although injury has resulted where proper care was not exercised. Treatment is best made with a small paint brush in October. The bark should not be cut or probed previous to treatment. Only the borer holes should be covered with the paint. A complete ring of the material should not be made around the tree. The material is poisonous and should be mixed out of doors to prevent inhaling the poisonous fumes.

SOOTY BLOTCH AND FLY-SPECK

(Gloedes pomigena (Schweinitz) Colby)
Leptothyrium pomi (Montagne & Fries) Saccardo)

Sooty blotch and fly-speck, although caused by two different fungi, are here considered under one heading because they frequently appear together and are controlled by identical measures.

Sooty blotch (figure 17) appears on the fruit as sooty-brown or black spots or blotches, which may measure only ¼ inch in diameter or which may coalesce and cover the entire apple. Dealers often call this condition "cloud" or "cloudy fruit." The spots show a radiating structure composed of a thin felt of the dark, interwoven threads of the fungus.

Fly-speck, as the name indicates, consists of groups of black, shiny dots on the apple, closely resembling those made by flies.

FIGURE 17. SOOTY BLOTCH AND FLY-SPECK ON APPLE FRUIT

Sooty blotch and fly-speck are diseases of considerable economic importance in New York. Although the disfiguration caused by the fungi is superficial, it often reduces the grade and the market value of the fruit.

Control

These diseases usually are controlled easily where the customary summer applications are made for the control of codling moth and apple scab (pages 13 to 17). Where sooty blotch has been destructive, apply a fungicide in the summer sprays.

BROOKS FRUIT-SPOT

(Caused by the fungus *Mycosphaerella pomi* Passerini)

Brooks fruit-spot, known also as *Phoma fruit-spot,* is a disease of apples found in eastern New York, where it has caused considerable loss in some years. It has occasionally been found in western New York, but not to a serious extent.

Jonathan, Baldwin, Tolman Sweet, Grimes Golden, Rome Beauty, and Stayman Winesap are the varieties most commonly affected. The disease has been found also on Rhode Island Greening, Bell-flower, Ben Davis, Delicious, and Mann.

The spots, which seldom exceed $^{8}/_{10}$ inch in diameter, are red or black when they are on red areas of the fruit, and dark green or green on yellow surfaces. The center is usually flecked with black. The spots are irregular in outline, slightly sunken, and usually more abundant near the calyx end of the apple. They are often inconspicuous at picking time. If, however, the fruit is not placed at once in cold storage, the spots usually become more sunken and considerably larger, with a corky layer under the skin.

The Brooks fruit-spot, which is a fungous disease controlled by spraying, is often confused with stippen. Stippen is a

fruit-spot on apples caused by sudden changes in the water supply of the tree, and consequently cannot be controlled by spraying. The sunken spots caused by stippen are similar to those caused by the Mycosphaerella fungus in the early stages. At picking time, however, the Brooks spots show black specks which are not present in stippen. At this time the spots caused by stippen usually turn brown, are more sunken, and have a distinct dry spongy area underneath which is not present under a Brooks spot. An apple affected with stippen will usually be found to contain brown streaks or spots of dry, spongy flesh throughout its pulp; such streaks or spots are not present with Mycosphaerella fruit-spot.

Control

Under New York conditions, where the regular summer sprays containing sulfur and lead arsenate are applied, this disease is adequately controlled.

In orchards where DDT or other organic insecticide has been substituted for lead arsenate, Brooks fruit spot may occur. In such orchards, use ferbam as the summer fungicide instead of sulfur.

JAPANESE BEETLE

(*Popillia japonica* Newman)
(See also under *Peach*, page 76)

The Japanese beetle is usually prevented from doing extensive damage in the commercial apple orchard by the lead arsenate or DDT sprays used for other pests. Apples ripening early in August may lack enough residue to repel the beetles from softening fruit. The same controls are suggested as for early peaches.

TWO LATE-SUMMER CATERPILLARS

Yellow-Necked Caterpillar (*Datana ministra* Drury)

Red-Humped Caterpillar (*Schizura concinna* Smith & Abbot)

The yellow-necked and the red-humped caterpillar, each well described by its common name, often attract attention in August. They feed in colonies, and strip the leaves from occasional branches. They are most abundant on young trees that have not been sprayed. The injury caused by these caterpillars is not so serious as appearances would indicate. They work late in the season, after the foliage has reached maturity, but trees badly defoliated are more subject to winter injury.

Control

On bearing trees that are regularly sprayed, these caterpillars are of little importance. On young trees jar the caterpillars to the ground and crush them or spray the tree with lead arsenate or DDT while the caterpillars are small.

PEAR

A PRACTICAL spray schedule for pears in New York must be built around the control measures required for **pear psylla**, for this pest is by far the most serious of any to the pear crop. The **pear tarnished plant bug, pear midge, stink bug, fruit-tree leaf roller, green fruit-worms, sinuate pear borer, rose leaf beetle,** and **quince curculio** cause damage in some orchards. The most important disease of pears is **fire blight,** but **pear scab, sooty blotch, leaf spot,** and **Fabraea leaf-blight** and **fruit spot** are important in some orchards. The spray schedule includes sprays for all these. All growers do not have to apply all of the sprays. The grower should therefore, select from the schedule those sprays needed to protect his particular orchard.

SPRAY OUTLINE

The choice of control measures for **pear psylla** depends upon the availability of materials and upon the experience of the individual grower as to other insect problems in his orchard. A basic schedule consists of a "late dormant" application followed by one or more of the later sprays if necessary.

SPRING APPLICATIONS

Dormant spray

(When the buds are not yet showing green)

Superior dormant oil	3 gallons
*Blood albumin (actual)..	2 ounces
Water to make.....	100 gallons

*Directions for tank mixing are on page 92.

This treatment is made where **pear leaf blister mite** is troublesome.

One pint of nicotine sulfate is added to the oil or used separately if **pear thrips** are a problem. The application is made when the thrips are "swarming" on the opening buds.

Late dormant spray

(From the stage when blossom bud scales are loosened until green leaf tips are showing)

Elgetol, Krenite, or Dinitrosol (DNC materials), 1 gallon in 100 gallons of spray, applied in the green-tip stage controls both **pear psylla** and **sooty blotch.** If sooty blotch is not a problem, either 2 quarts or 2 pounds of a DNC material may be used in this spray to kill **pear-psylla** eggs. The new DNBP materials (DN–289 or Elgetol–318) may be used against psylla eggs at a concentration of 2 quarts to 100 gallons of spray mixture.

Parathion may be used at 1 to 1½ pounds or EPN at ¾ pound in 100 gallons of spray mixture to kill pear psylla eggs at this time in place of the DN materials. Parathion and EPN appear to be less injurious to the trees and also allow somewhat more leeway in timing the treatment than do the DN materials. These materials are probably not effective against **sooty blotch.**

Pre-blossom spray

(When the blossom buds begin to separate in the cluster)

A pre-blossom application is necessary only in orchards where **pear scab** or **pear midge** is a problem. For **scab** control, lime-sulfur 1–50 (2 gallons in 100 gallons of water) or a 2–10–100 bordeaux mixture may be used.

Pear scab caused serious loss in several western New York pear orchards in 1952. In these orchards, a ground spray was very effective when applied in the spring of 1953 (page 54).

The most effective control for **pear midge** is 2 pounds of DDT powder to 100 gallons of spray applied when the blossom buds are swollen but before the sepals have begun to separate and again 7 days later. At this time the midge flies are usually "swarming" on the trunks and will readily take flight if disturbed. If a fungicide is necessary, elemental sulfur may be used.

Special bloom spray

*(When three-fourths of the blooms are open in orchards where **fire blight** is a problem)*

Copper sulfate	2 pounds
Hydrated lime.....	6 pounds
Water to make.....	100 gallons

or

20–80 copper-lime dust

One application usually is made when three-fourths of the blooms are open; if **fire blight** has been very severe, you may make an additional early application when about one-fifth of the blossoms are open. The possibility of a reduction of the set

of fruit and of fruit russeting by copper applications in bloom should be balanced against the likelihood of blossom infection in deciding whether to apply the material in individual orchards. (See *special bloom spray* for apple, page 10).

The spray application is supplementary to such measures as cutting out or chemical treatment of cankers, pruning out blighted branches and suckers, and breaking off blighted fruit spurs. These control measures are discussed in detail in Cornell Extension Bulletin 405, *Fire Blight and Its Control.*

Petal-fall spray

(When the last of the petals are falling)

Elemental sulfur at manufacturers' directions
Parathion ..... 1 or 2 pounds
Water to make ..... 100 gallons

The parathion in the formula is effective against **false tarnished plant bug, fruit tree leaf roller, green fruit worms,** and **plum curculio.** DDT, lead arsenate, and lime, 2 pounds of each, may be used for control of the pests mentioned. In orchards where pear psylla is the only problem, this spray may be omitted.

Bordeaux mixture, 2–10–100, may be used in place of the elemental sulfur to control **pear scab,** and nicotine sulfate, 1 pint in 100 gallons of spray, may be used with bordeaux to control **false tarnished plant bug.** Lead arsenate, DDT, or parathion may be used with the bordeaux. Parathion may injure the foliage on the Bosc variety in some locations and in some years and should be used cautiously on this variety.

Insecticides should not be used on open blossoms.

First-nymph spray

(About a week to 10 days after the petals have fallen)

Elemental sulfur at manufacturers' directions
Parathion ..... 1 to 2 pounds
Water to make..... 100 gallons

This spray is made especially for **pear psylla,** but also furnishes protection against **plum curculio** and **pear scab.** Any one of the formulas listed under early summer sprays may be used where **pear psylla** alone is a problem.

Special spray for rose leaf beetle, quince curculio, and sinuate pear borer

(About June 10; usually necessary only in eastern New York orchards wherever these pests may be a problem)

Lead arsenate ..... 3 pounds
Hydrated lime ..... 3 pounds
Spreader ..... ½ pound
Water to make..... 100 gallons

If **sinuate pear borer** is a problem, the lead arsenate and lime are increased to 5 pounds each, or 2 pounds of *DDT* is added to the spray mixture.

SUMMER SPRAYS

*(When **psylla** or **codling moth** becomes threatening)*

Early summer sprays

(In July when most of the second-brood psylla eggs have hatched)

At this time any one of three mixtures may be used for **pear psylla:**

1. Parathion (15 per cent wettable powder) .... 1 pound
   Water to make ..... 100 gallons
2. Cubé root (5 per cent rotenone). 2 pounds
   Summer oil ..... 2 quarts
   Blood albumin emulsifier ..... 2 ounces
   Water to make..... 100 gallons
3. EPN ..... ½ pound
   Water to make..... 100 gallons

Elemental sulfur may be added to formula 1 or 3 where **pear scab is a** problem.

Excellent control of **sooty blotch** and of **Fabraea leaf and fruit spot** may be obtained by the use of 1 pound of ferric dimethyldithiocarbamate (ferbam) to 100 gallons in the summer sprays.

If **codling moth** is a problem, formula 1 or 3 is recommended.

Late summer spray

(Early in August if psylla becomes abundant and threatens to smut the fruit or if the second-brood codling moth is a problem)

In areas of New York where **codling moth** is troublesome, late injury may be prevented by using a mixture of 1 pound of 50 per cent DDT and 1 pound of parathion. Where codling moth is not a problem, the DDT is omitted. If DDT is omitted any of the formulas given under early summer sprays may be repeated at this time if necessary for **psylla.** The spray usually is applied during the first two weeks of August.

DESCRIPTION OF DISEASES AND INSECTS

PEAR PSYLLA

(Psylla pyricola Foerst.)

The pear psylla is by far the most important insect pest of the pear in New York. The insect is more of a problem in large plantings and in sheltered orchards. Where it is not controlled, it often causes early defoliation and loss of crop, and so weakens the trees that they suffer winter-killing and a reduction in the succeeding year's crop.

The adults pass the winter under flakes of bark on pear and other near-by trees, and in trash and other shelter along adjacent fences and hedgerows. The psylla adults resembling tiny cicadas are about $^1/_{10}$ inch long, are dark reddish brown, and have relatively large, transparent wings which slope roof-like over the abdomen.

The adults or flies emerge from their hibernating quarters during sunny days in early spring when the temperature is above 50° F. If the weather continues warm, they crawl out on the smaller branches and spurs of the trees and in a few days the females begin to lay eggs. In some seasons most of the eggs have been deposited by the time the blossom buds separate in the cluster, but in cool seasons egg-laying may continue through the blossoming period. The small, elongate eggs are laid end to end in crevices around the buds, mainly on the underside of the smaller branches and fruit spurs and later on the lower surface of the opening leaves along the midrib. Although they are white when laid, the eggs soon change to lemon-yellow, deepening to orange as they near hatching. The eggs hatch in from nine days to four weeks, depending on the temperature. The majority of the eggs hatch during the blossoming period, and in normal seasons hatching is practically completed about a week after the petals have fallen although in some years the last eggs are not hatched until two weeks after petal fall.

The newly hatched nymphs migrate to the opening buds and settle at the bases of the leaf petioles and the fruit stems, where they suck out the plant juices. They grow rapidly, passing through five immature stages and become winged adults at the fifth molt. During the early stages, the nymphs are yellow and are covered by a sticky excretion called *honeydew*. The later stages are brown and are known as *hardshells*. During these stages relatively little honeydew is secreted.

The completion of the life cycle requires about a month, and there are three or four generations in a season. Each female lays about 500 eggs. Under favorable conditions the insect may increase to enormous numbers, even from a few overwintered flies.

The feeding of the nymphs dwarfs the leaves and fruit, produces brown, dead areas on the foliage, and in severe instances causes it to drop prematurely. Early defoliation is often followed by winterkilling of branches and by a reduction in the crop for several succeeding years. The fruit is often badly stained and reduced in market value by a sooty fungus which grows in the sticky coating of honeydew.

Control

The pear psylla has been a difficult pest to control in the past and no single treatment has been reliable when it has been abundant. Control measures may be divided into dormant and summer measures. The dormant applications are: (1) a 3 per cent emulsion of a "superior" dormant-type oil as the buds are swelling; (2) 2 quarts of DNC slurry or 2 pounds of DNC powder or 2 quarts of DNBP materials in the green-tip or late dormant stage; (3) 1 pound of 15 per cent parathion powder in the green-tip or late dormant stage. Ordinarily, only one of these treatments is used; the others are unnecessary.

Make the oil treatment at the time the psylla flies are active on the trees. The oil treatment is also effective in controlling pear leaf blister mite and eggs of the fruit tree leaf roller.

Control of psylla with DN materials is directed at the eggs and should be applied after most of the eggs are laid, but before they start to hatch. The majority of the psylla eggs are deposited on the underside of the spurs and the smaller branches and on the water sprouts, so the most effective method is to spray from the ground.

If sooty blotch is a problem, 4 quarts of a DNC material may be used to control both psylla and sooty blotch.

One pound of 15 per cent parathion in 100 gallons of spray is effective against eggs of the pear psylla. Make this treatment in the green-tip or late dormant stage and time it in the same way as the DN materials, that is after most of the eggs are laid. Indications are that parathion is safer to use on pear foliage at this time than the DN materials.

You may need to make summer applications if early sprays have been omitted or carelessly applied. Any one of the three treatments listed on page 50 is satisfactory for this purpose. Applications are most often made about the middle of July at the time when most of the second-brood eggs have hatched or in early August. Apply the treatments, however, whenever the population of nymphs becomes large enough to endanger the crop by secretion of honeydew with accompanying smutting.

You may use parathion as it is compatible with DDT or sulfur. The oil-rotenone combination is equally effective but should not be used within 2 weeks before or after a DDT application or within 4 weeks before or after a sulfur application.

FRUIT TREE LEAF ROLLER

(*Archips argyrospila* Walker)

The fruit tree leaf roller, together with the green fruitworm, causes the so-called gnarly or goose-necked pears. It is a serious pest in only a few orchards.

Control

Whenever fruit tree leaf roller becomes unusually troublesome, it can be checked by the application of a 3 per cent "superior" dormant-type oil in the green-tip or delayed-dormant stages.

In addition to the oil spray an application of 2 pounds of 50 per cent DDT wettable powder in 100 gallons of spray mixture is advised as the last of the petals are falling. It is important that this application be made at the time indicated because a delay of a few days may reduce the effectiveness of the spray considerably. This pest is discussed further on page 31.

PEAR PLANT BUG

(*Neolygus communis* Knight)

The pear plant bug is present in occasional pear orchards throughout the State, and may cause a large proportion of the fruit to become knotty, deformed, and even dwarfed. This pest is often referred to as the *false tarnished plant bug.*

The insect passes the winter in the egg stage in the bark of the smaller branches of the trees. The eggs hatch during the blossoming period, and the young nymphs, after feeding for a time on the expanding leaves, attack the fruit as soon as it has set. In feeding, the nymphs puncture the fruit and suck out the plant juices. The nymphs mature about the middle of June. The adult is about ¼ inch in length and is light brown. There is only one brood a year. Most of the injury is caused during June, while the fruits are still small.

Control

The pear plant bug is controlled by the use of 2 pounds of 50 per cent DDT wettable powder in 100 gallons of water. Make this application when the plant bugs appear. If you use DDT to control leaf roller, usually an extra application will not be needed to control plant bug.

FIRE BLIGHT

(*Erwinia amylovora* (Burr.) Winslow et al)

A full discussion of fire blight, a bacterial disease of pear and apple, and its control is given in Cornell Extension Bulletin 405, *Fire Blight and Its Control.* It is included here because one of the control measures used in orchards where blight has been a problem in the past is a bloom application of 2–6–100 bordeaux mixture or 20–80 copper-lime dust. One application is usually made when three-fourths of the blooms are open but, if the disease has been very severe, an additional early application may be made when about one-fifth of the blossoms are open. The possibility of a reduction of the set of fruit and of fruit russeting by copper applications in bloom should be balanced against the likelihood of blossom infection in deciding whether to apply the material in individual orchards.

The phenyl mercury sprays have been used in limited tests in New York with some control of blight and with no apparent reduction of fruit set. Because of a reduction in set as high as 50% in 1953 with bloom sprays of mercury, such sprays are not suggested for 1954.

In several States, Zineb (zinc ethylene bis dithiocarbamate) has been reported favorably for fire blight in bloom sprays. There has been no blight in New York experiments to test its efficiency.

Two antibiotics, streptomycin and terramycin, have been extremely effective in fire-blight control in several states. Streptomycin at the higher dosages has caused fire-blight control in several States. Strepising if safe dosages are determined and may replace present materials if they can be made available at a reasonable cost.

At present, spray applications are supplementary to such measures as cutting out cankers or treating them with the cobalt nitrate paint as described in Extension Bulletin 405.

PEAR SCAB

(Caused by the fungus *Venturia pyrina* Aderhold)

Pear scab is similar in appearance to apple scab and is caused by a closely related fungus, but the two diseases are distinct. The pear-scab fungus does not attack apple, nor does the apple-scab fungus attack pear.

The pear-scab fungus, like the apple-scab fungus, overwinters as partly developed fruiting bodies (perithecia) in the old fallen scabby leaves. Unlike apple scab under New York conditions, it overwinters also to a considerable extent in affected twigs. The young twigs are rather commonly affected but the spots are inconspicuous and easily overlooked. Limited observations in western New York indi-

cate that in that area a considerable proportion of the pear-scab fungus fails to survive the winter in the twigs so that the overwintering stage in the leaves is much more important. Pear scab has been less serious in the Hudson Valley, and the importance of the two methods of passing the winter in that area is not known.

The spring spores (ascospores) of the pear-scab fungus mature in the perithecia somewhat later than do those of the apple-scab fungus. When the ascospores are ripe, they are shot out of the dead leaves during wet periods and infections take place as described for the scab on apple. Summer spores also are produced on the twigs affected and are washed to leaves and fruit, creating an important method of spread which rarely exists with apple scab in New York.

In general, pear scab is not serious except on such varieties as Flemish Beauty, Winter Nelis, and Easter Beurre. In 1946, 1947, 1948, and particularly in 1952 and 1953, pear scab was serious on the fruit of such commercial varieties as Seckel, Bartlett, and Bosc in a number of orchards in western New York. Previously, in the years 1932 to 1936, the disease was serious on these varieties in the same area. During those outbreaks applications of fungicides during the pre-blossom period were of great value.

After a complete loss from fruit scab in 1952 a number of orchards received a ground spray of 2 quarts of paste DNC per 100 gallons. The spray was applied at the rate of 400 to 600 gallons of spray per acre when the trees were still dormant in the spring of 1953. The ground spray was followed by a pre-blossom spray, and excellent scab control was obtained. Pear scab was again severe in 1953 in a number of orchards that did not receive the ground spray and the pre-blossom application. The ground spray is best applied in the dormant spray, but it may be applied through the green-tip stage (See also *Apple*, page 23).

PEAR LEAF BLISTER MITE

(*Eriophyes pyri* Pagenstecher)

The leaves of pear and of apple are often disfigured by small, reddish or greenish yellow blisters, caused by blister mites. These later turn brown. Badly infested leaves turn somewhat yellow and fall prematurely. The adult blister mites pass the winter in the buds, beneath the second and third scales. With the bursting of the buds in the spring, the mites migrate to the leaves, burrow through the upper surface, and lay eggs. The young mites feed on the tender tissue inside the leaf, and cause the formation of swellings or blisters. When mature, the mites escape from the blisters through minute holes in the underside of the leaf. They then migrate to fresh leaves and start new blisters. Breeding is continued throughout the summer.

Control

Pear leaf blister mite is seldom serious enough to warrant special control measures. It is readily controlled by dormant-type oil sprays or lime-sulfur, 1–15, applied in the spring before the buds break. The oil sprays used for psylla and thrips will control this pest also.

CODLING MOTH

(*Carpocapsa pomonella* Linnaeus)

(See also under *Apple*, page 36)

The codling moth is an important pest of the pear in some sections of the State. Because of the tougher character of the pear skin, a larger proportion of the larvae are thought to enter through the calyx cup than in the case of the apple.

Control

Apply the first spray for the control of codling moth shortly after all the petals have fallen. Either 2 pounds of 50 per cent wettable DDT powder or 3 pounds of lead arsenate in 100 gallons of water may be used in this spray. The DDT or lead

arsenate is usually added to the first-nymph spray (page 50). Additional sprays, if necessary, should contain 2 pounds of 50 per cent wettable DDT powder in 100 gallons of water. Applications may be made at 10- to 14-day intervals. Make no DDT application within 3 weeks of harvest to prevent excessive toxic or visible residues. If pear psylla is also a problem, ½ pound of 15 per cent parathion powder or 1 pint of nicotine sulfate may be used with the DDT. Do not use oil with DDT on pears to control pear psylla because this would injure the foliage and leave excess toxic residues.

A 5 per cent DDT dust may be substituted for the DDT sprays if desirable. DDT dust applications should not be made within two weeks before the fruit is to be harvested.

QUINCE CURCULIO

(Conotrachelus crataegi Walsh)

In a few scattered orchards throughout the State, the quince curculio sometimes causes considerable injury to pears. Fruit injured by the feeding and egg-laying punctures of the curculio frequently becomes knotty and deformed, but the presence of feeding punctures, even without deformation will cause the pears to drop just before picking time.

Control

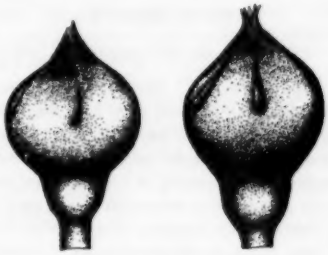
Spray infested orchards with 3 pounds of lead arsenate, 3 pounds of hydrated lime, and ½ pound of spreader in 100 gallons of spray mixture, as soon as the beetles emerge from the ground. DDT is not effective in controlling this pest. The time of emergence varies considerably from year to year. In the Hudson Valley the curculio usually appears the first week in June, while in western New York it may appear anytime between June 15 and July 15. One way to determine the time of application is to watch for the first feeding punctures on the fruit. Look for them first near the stem end of the pears. Usually, you may combine this application with the one timed for the control of the rose leaf beetle and the sinuate pear borer. During some seasons a second application is advisable. Two applications are usually enough.

PEAR MIDGE

(Contarinia pyrivora Riley)

The pear midge is now a major pest in the Hudson Valley, and it also causes serious injury in some orchards of western New York. In badly infested orchards, the entire pear crop of certain varieties may be destroyed. All varieties are attacked, but Lawrence is the most seriously injured and Kieffer the least.

The adult pear midge is a small, mosquito-like fly, distinguishable from other midges by its more delicate build and its unusually long legs. The midges usually emerge from the ground at about the time the blossom buds of Clapp Favorite are separating in the cluster. The female soon moves to the buds, and, by means of her long, flexible ovipositor, lays her eggs inside the unopened blossoms. This is done as soon as the petals have developed enough to permit the insertion of the ovipositor (figure 18). The eggs hatch in about 1 week, and the tiny larvae work their way into the ovary and hollow out a



Drawing by F. G. Mundinger

FIGURE 18. STAGES IN BUD DEVELOPMENT OF PEAR

A: Sepal closed; proper stage for first spray
B: Sepal open showing pink; too late for spray

large cavity in the center of the developing fruit.

Infested fruits are at first larger than normal, but later they become stunted and deformed and in a few weeks drop to the ground. When the larvae are full-grown, they either drop to the ground through cracks which develop in the side of the fruit or drop with the fruit. They usually pupate soon after entering the soil, and remain in this state until the following spring.

Control

The pear midge can be controlled by DDT applications at the rate of 2 pounds of wettable powder in 100 gallons of spray mixture. Make two applications when the blossom buds are swollen but before the sepals have begun to separate and again seven days later. At this time the midge flies are usually "swarming" on the trunks and readily take flight if disturbed. Spray the entire tree including the trunk. Nicotine sulfate, 1 pint in 100 gallons of the spray mixture, has been extensively used in the past. A single application is made after the flies are out and the sepals have separated on the most advanced buds. The timing of this spray is highly important and for this reason most New York growers now use DDT.

PEAR THRIPS

(Taeniothrips inconsequens Uzel)

Although pear thrips are present throughout the State, they have been destructive chiefly in parts of eastern New York. During some seasons the insect causes severe blasting of blossoms and leaf buds and a heavy reduction of the crop in a considerable number of orchards.

The adult thrips are slender, brownish insects about 1/20 inch in length, with long, narrow wings fringed with long hairs. In the spring they emerge from the soil and appear on the trees, usually just as the buds are bursting. They soon work their way into the opening buds and attack the tender flower and leaf parts. If the thrips are numerous, and especially if cool weather retards the further opening of the buds, many blossom clusters are shriveled or blasted and later fall off, while others are stunted and deformed and drop their fruit prematurely. The thrips lay their eggs mainly in the stems of the blossoms and leaves, beginning as soon as the buds open. The young thrips are small, white creatures, with red eyes, and they hatch in numbers during the blossoming period. They feed in the calyx cups of the blossoms and on the foliage, thus adding to the injury caused by the adults. They become full-grown in 2 or 3 weeks, fall to the ground, and enter the soil, sometimes to a considerable depth. In the fall they change to pupae. The pupae pass the winter in tiny cells in the ground.

Control

Control for pear thrips consists of spraying with 1 pint of nicotine sulfate in 100 gallons of either a 3 per cent dormant-type oil emulsion or commercial oil emulsion diluted at manufacturers' recommendations. Because the time for effective spraying is short, watch your orchard carefully and spray as soon as thrips are numerous on the buds and branches. If thrips continue to appear, you may need to make a second application a few days later. In seasons when large numbers of thrips swarm on the buds before these are expanded enough for the insects to enter, the thrips can be successfully controlled. When, however, they emerge a few at a time and the buds are open enough for them to enter, satisfactory control is impossible. This application controls pear psylla as well as pear thrips.

SINUATE PEAR TREE BORER

(Agrilus sinuatus Olivier)

The sinuate pear tree borer occasionally causes damage to pear trees in eastern

New York, especially in orchards of low vigor.

The adult stage of the insect is a shiny copper-colored beetle about ⅓ inch long. It lays its eggs in cracks on the bark of the trees and from these the slender white grubs hatch in June and July. These eat out narrow winding burrows in the sapwood and, in the case of smooth-barked trees, these zig-zag trails later become conspicuous.

The foliage of the infested trees becomes sparse, heavily infested branches die, and eventually the entire tree succumbs.

Control

DDT, in 2 pounds of 50 per cent wettable powder in 100 gallons of water, applied about June 10 and again 2 weeks later kills the adult beetles as they feed on the trees. You may need to make a third application if unsprayed trees are nearby.

PEAR LEAF-BLIGHT AND FRUIT-SPOT

(Caused by the fungus *Fabraea maculata* (Leville) Atkinson)

Pear leaf-blight is caused by the same fungus that produces leaf-blight on quince (page 87).

Leaf-blight occurs commonly on pears in practically all nursery districts. The greatest damage is on pear seedlings in the nurseries, but occasionally severe injury is done to leaves and fruit of trees in bearing orchards.

The leaf-blight fungus causes a spotting of pear leaves similar to that produced on quince by the same fungus. The spots on the leaves differ from the spots of the Mycosphaerella leaf-spot as they are smaller, more nearly circular, and darker colored. There is one raised black dot in the center of the leaf-blight spot, in contrast to the numerous small black bodies in the Mycosphaerella leaf-spot. The spots on the fruit are at first red, but later they become dark-colored. The skin is roughened, and cracking of the fruit may follow.

Control

Excellent control of the Fabraea leaf- and fruit-spot, and of sooty blotch as well, may be obtained by the use of 1 pound of ferric dimethyldithiocarbamate (ferbam) in 100 gallons in the summer sprays on pear.

MYCOSPHAERELLA LEAF-SPOT

(Caused by the fungus *Mycosphaerella sentina* (Fries) Schroeter)

Mycosphaerella leaf-spot is usually called *Septoria leaf-spot* or simply *pear leaf-spot*.

When leaf infections are heavy, defoliation may take place by August or earlier. This checks the ripening of buds and shoots, and makes the tree susceptible to winter injury. The leaf-spot is recognized by the dark, angular spots with light gray centers, which contain the very dark, pinpoint-like fruiting bodies of the fungus. The fungus overwinters in the fallen leaves, from which its spores are shot in the spring during rain periods.

This disease is of little importance in well-sprayed pear orchards. Frequent inquiries regarding it are received from owners of unsprayed pear trees.

CHERRY

UNDER New York conditions, cherries are sprayed principally to control **leaf spot, brown rot,** and **fruit flies.** In some locations the **plum curculio** may require attention. **Black cherry aphid** is confined as a pest mostly to sweet cherries.

SPRAY OUTLINE

FOR SOUR CHERRIES

Pre-blossom spray for sour cherries

(Just before the blossoms open)

Lime-sulfur	2½ gallons
or	
Elemental sulfur (actual sulfur)	5 pounds
or	
Captan	2 pounds
Water to make	100 gallons

This spray is applied for the control of **brown-rot blossom-blight** (page 61). It is important in most seasons on English Morello, and may be needed in some years on Montmorency cherries. Promising results were obtained with captan against brown rot blossom blight in sweet cherries.

Petal-fall spray for sour cherries

(When the last of the petals are falling)

Low-soluble copper at manufacturers' directions plus 1 pound of lime for each ¼ pound of metallic copper in the mixture plus 1 pint of oil type sticker. Lead arsenate, *2½ pounds in 100 gallons of spray, is included.

or

Elemental-sulfur paste	10 pounds
Oil type of sticker	1 pint
Hydrated spray lime	2½ pounds
*Lead arsenate	2½ pounds
Water to make	100 gallons

or

Lime-sulfur	2½ gallons
*Lead arsenate	2½ pounds
Water to make	100 gallons

or

Glyodin (341)	1½ pints
*Lead arsenate	2½ pounds
Lime	2½ pounds
Water to make	100 gallons

or

Ferbam	1½ pounds
*Lead arsenate	2½ pounds
Water to make	100 gallons

*Lead arsenate should be reduced to 1 pound on English Morellos to reduce arsenical injury ("dry stem").

Stem-end injury to Montmorency fruit, in the form of a black ring, appeared in appreciable amounts in a few orchards that received sprays of low-soluble copper in 1945. Apparently injury is more likely when the copper is used in the shuck and the first fruit-fly spray. Two organic fungicides that have shown promise as substitutes for low-soluble copper in the shuck and first fruit-fly sprays to prevent fruit injury are glyodin (341) at 1½ pints per hundred gallons and ferbam used at 1½ pounds per hundred gallons of spray. (See page 66.)

Either 341 or ferbam used in shuck-fall and first-fruit-fly sprays prevents stem-end injury to fruit caused by fixed coppers but will not prevent arsenical dry stem. The use of one or more sulfur sprays in July reduced dry stem in English Morello cherries in 1950 (page 66). Lime should be used in all cherry sprays in orchards that receive lead arsenate in fruit-fly sprays.

Glyodin (341) at 1½ pints, or ferbam at 2 pounds, in 100 gallons of spray may be substituted for the copper in the shuck and first fruit-fly spray. Captan at 2 pounds also shows promise but has not yet been adequately tested in New York (page 66).

The addition of ½ pound of soybean flour improves the spreading qualities of the lime–lead-arsenate mixture. Parathion or methoxychlor may be used in place of lead arsenate where curculio is a severe problem as discussed in the plum schedule on page 79. Elemental sulfur should be used with these materials.

This spray is effective against **leaf spot, brown rot,** and **curculio.**

Bordeaux mixture at 1½–6–100 may also be used, but this highly effective fungicide may injure the foliage and dwarf the fruit. Dwarfing of the fruit has followed lime-sulfur applications also. During a 4-year test, higher yields were obtained with low-soluble copper and with sulfur paste

than with lime-sulfur or bordeaux mixture.

For the grower who uses a dusting schedule, a 90–10 sulfur–lead-arsenate mixture is indicated. If **curculio** is abundant, an 80–20 mixture of the same materials may be used.

Shuck spray for sour cherries

(When the shucks are falling from the fruits that are going to set)

The same suggestions and materials as those mentioned under petal-fall spray apply to the shuck spray.

This spray is effective against **curculio, leaf spot,** and **brown rot.**

For dust, an 80–20 sulfur–lead-arsenate mixture is indicated.

Later sprays for sour cherries

These later sprays are for **cherry fruit flies, leaf spot,** and **brown rot.**

For canning cherries to be washed

First fruit-fly spray for sour cherries

*(A week after the **fruit flies** have first appeared or about the time Early Richmond first shows a tinge of color)*

The materials and suggestions are the same as those given under the petal-fall spray (page 58).

Second fruit-fly spray for sour cherries

*(About 10 days later than the first **fruit-fly** spray or when Montmorency begins to color)*

The materials and suggestions are the same as those mentioned under the petal-fall spray (page 58).

For a dust, a 90–10 sulfur–lead-arsenate mixture is indicated. The applications are made at the same times as indicated for sprays; but, if there are heavy rains, extra dust applications should follow them.

Third fruit-fly spray for sour cherries

In some years, such as 1952 and 1953, a third application is needed 10 days after the second because of the late activity of the fruit-flies.

Parathion, at the rate of 2 pounds of 15 per cent powder, or methoxychlor, at the rate of 2 to 3 pounds of 50 per cent powder, may be substituted for the lead arsenate on a trial basis. Over the past two seasons these materials have equalled lead arsenate in fruit-fly control in the tests at the Geneva station. These materials are of particular value on the Morello variety where arsenical dry-stem is more often a problem. Parathion and glyodin (Crag 341) should *not* be used together.

After-picking spray

(Soon after harvest)

The choice of fungicides given under the petal-fall spray (pages 58 and 59) applies for this application. The lead arsenate should be omitted.

For sour cherries to be used as fresh fruit

The schedule outlined on page 61 for the **fruit-fly** sprays for sweet cherries should be followed.

FOR SWEET CHERRIES

Dormant spray for sweet cherries

(Before the buds are open)

The DNC sprays are effective for the control of **black cherry aphid.** Use 1½ quarts of a liquid or 1½ pounds of powdered DNC (Elgetol, Krenite, and the like) material in 100 gallons of water.

The newer DNBP materials (DN–289, Elgetol 318) may also be used at the rate of 1 quart in 100 gallons of spray.

Pre-blossom spray for sweet cherries

(Just before the blossoms open)

Lime-sulfur	2 gallons
Water to make	100 gallons
or	
Elemental-sulfur paste	10 pounds
Oil type of sticker	1 pint
Water to make	100 gallons
or	
Captan	2 pounds
Water to make	100 gallons

Promising results were obtained with captan against blossom blight in 1953. Buds appeared to be invigorated by this spray.

The pre-blossom spray is for control of **brown-rot blossom blight.** Additional sulfur applications in bloom may be needed. If no dormant spray was made for aphids, an application is needed at the green-tip stage. One pint of nicotine sulfate; from 3 to 5 pounds of potash fish-oil soap, 1 pound of soap flakes, or 3 pounds of spray lime may be added to the lime-sulfur to spread and activate the nicotine. From ¼ to ½ pint of TEPP or 1 pound of parathion may be substituted for the nicotine sulfate in the elemental-sulfur formula.

Usually, the nicotine spray is not so effective as the dormant DN sprays for aphid control.

Petal-fall spray for sweet cherries

*(For **leaf spot, brown rot,** and **plum curculio**)*

Lime-sulfur	2 gallons
Lead arsenate	2½ pounds
Hydrated spray lime	2½ pounds
Water to make	100 gallons
or	
Elemental-sulfur paste	10 pounds
Oil type of sticker	1 pint
Lead arsenate	2½ pounds
Hydrated spray lime	2½ pounds
Water to make	100 gallons
or	
Elemental sulfur (actual sulfur)	3 pounds
Ferbam	1 pound
Lead arsenate	2½ pounds
Water to make	100 gallons

The addition of ½ pound of soybean flour improves the spreading qualities of the lime-sulfur–lead-arsenate mixture.

Copper sprays are unsafe for use on sweet cherries

Parathion or methoxychlor may be used in place of lead arsenate as indicated in the sour cherry schedule (page 59).

A mixture of 3 pounds of elemental sulfur and 1 pound of ferbam is a promising formula to control brown rot, botrytis rot, and leaf spot. Ferbam and sulfur sprays may be alternated for the same result.

Shuck spray for sweet cherries

(When the shucks are falling from the fruits which are going to set)

The materials are the same as those outlined for the petal-fall spray.

The shuck spray is effective against **leaf spot, brown rot,** and **curculio.**

Later sprays

*(For **cherry fruit flies, leaf spot,** and **brown rot**)*

During the past few years the black cherry aphid has frequently required summer control measures. Any one of the following sprays may be used:

(1)	Tetraethyl pyrophosphate	¼ to ½ pint
	Water to make	100 gallons
(2)	Parathion	1 pound
	Water to make	100 gallons
(3)	Nicotine sulfate	1 pint
	Soap chips	1 pound
	Water to make	100 gallons

For sweet cherries to be used as fresh fruit

It is impossible to recommend a spray schedule that always gives satisfactory maggot control and at the same time insures freedom from spray residue. The following suggestions are offered:

First fruit-fly spray for sweet cherries

(A week after the ***fruit flies*** *first appear or about the time Early Richmond shows a tinge of color)*

Fine ground derris or cubé powder ..... 2 pounds
(containing from 4 to 5 per cent of rotenone)
Wettable sulfur at manufacturers' directions
Water to make ..... 100 gallons

Lime, bordeaux mixture, or lime-sulfur should not be used with derris or cubé powder. The paste forms of wettable sulfurs plus a sticker seem superior for this purpose.

Second fruit-fly spray for sweet cherries

(About one week after the first ***fruit-fly*** *spray)*

The formula is the same as that for the first fruit-fly spray.

Third fruit-fly spray for sweet cherries

(About one week after the second ***fruit-fly*** *spray)*

The formula is the same as that for the first fruit-fly spray.

For those growers who prefer to make only two **fruit-fly** sprays, it is advisable to use 3 pounds of derris or cubé powder to 100 gallons of spray instead of 2 pounds. Two applications may not give so satisfactory control as three, particularly if there are rain periods. Methoxychlor or parathion may be substituted for the derris on a trial basis if desired (page 59).

For processed sweet cherries that are to be washed

The schedule is the same as that outlined for sour cherries that are to be washed (page 59) except that the lime-sulfur is reduced to 2 gallons. **Coppers are unsafe for sweet cherries.**

After-picking spray for sweet cherries

The schedule is the same as that outlined for sour cherries (page 59) except that only 2 gallons of lime-sulfur is used and that sulfurs rather than coppers are used for sweet cherries.

DESCRIPTION OF DISEASES AND INSECTS

BROWN ROT

(Caused by the fungus *Monilinia fructicola* (Winter) Honey)

(See also under *Peach,* page 72)

The brown rot of stone fruits is particularly destructive to cherries in warm, wet seasons. Sweet cherries are more susceptible than are sour varieties. The life history of the fungus given on page 72 applies also when cherries are infected.

Brown-rot blossom-blight is frequently serious on sweet cherries, and on English Morello among the sour varieties in western New York but appears to be less common in the Hudson Valley. The subsequent development of the fungus on cherry is similar to that described under *peach* (page 72).

Control

The spray information service has recommended a pre-blossom application for sweet cherries, and for English Morello

as well, since blossom blight has more frequently been destructive on these varieties. In some years a pre-blossom spray may be needed on Montmorency.

Adequate control of brown rot is usually obtained in sour cherries by including a fungicide in the regularly applied sprays for control of leaf-spot, curculio, and fruit flies. For English Morello, it will probably be advisable to start the schedule of sprays with the pre-blossom, while for the other sour cherries the petal-fall will normally be the first spray.

For sweet cherries, a fungicide should be included in the regular schedule, beginning with the pre-blossom spray.

For control of brown-rot blossom blight, additional sulfur applications at bloom may be needed. The danger of reducing fruit set by the use of sulfur at bloom should be balanced against the danger of brown rot. Phygon at the rate of ½ pound in 100 gallons of spray gave no injury during 1951, 1952, or 1953 but too little blossom blight developed to test its effectiveness. Greenhouse tests indicate Phygon is effective up to 12 hours after the beginning of the rain. Promising results were obtained with captan against blossom blight. Buds appeared to be invigorated by the spray.

Copper sprays are unsafe for use on sweet cherries. The 1½ pint dosage of Crag 341 used on sour cherries has not been tested on sweet varieties. Ferbam gives satisfactory control of leaf spot but may fail to keep brown rot in check if used alone. Ferbam and sulfur sprays should be alternated or a mixture of 3 pounds of sulfur and 1 pound of ferbam in 100 gallons of spray mixture used to give combined control of leaf spot, brown rot, and botrytis rot. One or two pre-harvest sprays of 1 pound ferbam plus ½ pint of self emulsifying cotton seed oil in 100 gallons of water are effective in control of brown rot and botrytis rot and leaves no visible residue on red or black varieties of sweet cherries. On yellow varieties, an application of dusting sulfur about a week before picking permits you to leave the crop in the trees longer and thus to allow the fruit to attain greater size without appreciable loss from brown rot. Some difficulty is encountered in obtaining pickers where this practice is followed, because the dust irritates their eyes.

While captan gave excellent results in prebloom sprays on sweet cherries, it has not been tested for later sprays on sweet cherries. Information on its safety in these sprays is needed.

BLACK CHERRY APHID

(*Myzus cerasi* Fabricius)

The black cherry aphid frequently causes serious injury to sweet cherries in New York and may occasionally be serious on sour cherries. This pest passes the winter in the form of shining black eggs on the smaller branches near the buds. These eggs hatch as the buds are opening in the spring. The aphids reproduce so rapidly that within a few weeks they may curl the leaves of the terminal shoots and the fruit clusters. The injured leaves turn brown and die, and the fruit is dwarfed. The aphids also excrete large amounts of honeydew, which collect on the leaves and the fruit. A sooty fungus grows in the honeydew, making the fruit practically unmarketable.

Control

The most effective control of the black cherry aphid is obtained by the use of one of the DN compounds. Use either 1½ quarts of DNC slurry of 1½ pounds of DNC powder for each 100 gallons of spray. The DNBP materials may be used at the rate of 1 quart in 100 gallons of spray mixture. Applications of DNC slurry or powder may be made in the fall after all of the leaves have fallen from the tree, and both DNC and DNBP may be applied in the spring while the buds still are brown and do not show any green.

If you omitted a dormant treatment,

nicotine sulfate may be used in the green-tip stage but the results are less effective than those from the dormant DN materials. If an aphid infestation builds up in the summer you may include from ¼ to ½ pint of TEPP in the spray mixture for effective summer control. Do not use TEPP with lime or other alkaline materials. Parathion, at the rate of 1 pound in 100 gallons of spray mixture, will also give equally effective results.

CHERRY FRUIT FLIES

(Rhagoletis fausta Osten Sacken)
(Rhagoletis cingulata Loew)

Cherry fruit flies are present in all orchards of the State and cause most of the familiar wormy cherries. They are bright-colored flies, somewhat smaller than the house fly and distinguished by prominent dusky bands or markings on the wings. There are two species of these flies: the black cherry fruit fly, *R. fausta;* and the cherry fruit fly, *R. cingulata.* The abdomen of the black cherry fruit fly is entirely black, while that of the cherry fruit fly is marked by a series of distinct white crossbands (figures 19 and 20). The wing markings of the two species also differ. The cherry fruit fly is usually by far the more abundant species.

The cherry fruit flies spend about ten months of the year in the soil beneath the trees, in a puparium resembling a grain of wheat. They then change to the fly stage, emerge from the ground, and appear on the trees. Emergence begins about June 1 and continues for a month or longer. The black cherry fruit flies begin to appear 7 or 10 days earlier than do the cherry fruit flies.

On the trees the flies move actively about over the foliage and the fruit, and lap up almost any material present.

The female deposits her eggs in the flesh of the fruit, through small punctures. The eggs hatch into tiny, whitish, legless maggots, which burrow at first around the pit but later through the flesh. The outside of infested fruit usually appears perfectly normal until the maggot is nearly full-grown when sunken spots appear. When full-grown the maggot eats it way out of the fruit, falls to the ground, and enters the resting stage in the soil.

Control

For many years, lead arsenate at the rate of 2½ pounds in 100 gallons of the spray mixture has given excellent control under commercial conditions. Canning cherries are thoroughly washed before processing, and spray residues are effectively removed, thus permitting the use of a full schedule for fruit-fly control. This schedule cannot be followed on fruit that is to be consumed fresh. The modified schedule is built around the use of finely ground derris or cubé powder, a material which kills the fruit flies but is not considered objectionable as a spray residue. Derris or cubé powder cannot

FIGURE 19. THE BLACK CHERRY FRUIT FLY (RHAGOLETIS FAUSTA)

FIGURE 20. THE CHERRY FRUIT FLY (RHAGOLETIS CINGULATA)

always be relied upon for satisfactory results in orchards where maggot is difficult to control.

The first flies usually appear during early June, so apply the first spray about one week after the beginning of emergence and follow by a second spray from 10 to 14 days later. Since Morello cherries are picked later than are the other varieties, a third spray will be necessary to protect them until picking time. Morello cherries are susceptible to arsenical injury that causes fruit stems and fruits to shrivel; therefore, use no more than 1 pound of lead arsenate on these.

Where information on the emergence of the flies is not available, a fairly satisfactory method of timing is to apply the first spray to all varieties when the Early Richmond cherries are just beginning to show color or about June 10. Although the flies are usually present earlier, they do not deposit eggs in the fruit until it begins to color a little.

Substituting methoxychlor, at the rate of 3 pounds in 100 gallons of spray, or parathion at the rate of 2 pounds in 100 gallons, for the lead-arsenate sprays, was sucessful in the 1952 and 1953 seasons. Growers who are fearful of arsenical injury ("dry-stem") on varieties such as Morello and Montmorency may use one or the other of these materials on a trial basis.

When spraying cherries for the control of fruit flies, spray also interplanted trees and adjoining trees or hedgerows; otherwise the flies will harbor safely in these and later will move to the cherries and lay eggs before being killed. Spray also the first four or five rows of adjoining orchards. If interplanted with peaches, which cannot be safely sprayed, spray the cherries as soon as the first flies appear, to kill the flies before they can move to the peaches.

Where an effort is being made to prevent spray residue, thoroughly spray with lead arsenate all trees, bearing and nonbearing, interplanted with cherries, and all trees and hedgerows bordering the orchard. Control of maggot through the use of lead arsenate, or derris or cubé powder, on the cherry trees themselves would then be made much easier and the danger of excessive spray residues greatly reduced.

Where dusts are used instead of sprays, renew the covering after every heavy rain during the danger period.

CHERRY LEAF-SPOT

(Caused by the fungi *Coccomyces hiemalis* Higgins and *C. lutescens* Higgins)

Cherry leaf-spot is the disease which, when uncontrolled, causes the greatest loss to the cherry industry in New York. In years most favorable to the development of the leaf-spot, many orchards that were not properly sprayed were defoliated. Such defoliation weakens the trees and winterkilling is likely to follow. In addition to the immediate effect on the following years' crop, defoliation reduces the spur development, thus lowering the production for a number of years.

On an affected leaf, dark-blue spots, usually not more than ⅛ inch in diameter, appear. These spots soon become dark red or reddish brown, and during rainy weather light pink-colored masses appear on the underside of the leaf in the center of the spots. The spots may be on the fruit stems also, causing the fruit to ripen unevenly. Spots on the fruit occur rarely and are not of economic importance.

Montmorency cherries are affected by two diseases that cause the leaves to yellow and drop, and so are often confused. The first of these troubles to appear is the virus yellows which causes many leaves to turn yellow or light green and to drop, usually during the month of June. Purple spots caused by the leaf-spot fungus ordinarily begin to appear during June, but this primary infection is light and it is not until secondary infection occurs that the spots become numerous and

yellowing and dropping of leaves follows. The leaf-drop from the leaf-spot infection is usually from two to four weeks later than the drop from the yellows disease in the orchard. Leaves dropping as a result of the fungous leaf-spot bear many purple spots with flesh-colored masses of spores on the under surface of the leaves. Wetting the lower leaf surface causes the spore mass to gelatinize and to be more easily seen. Yellows-infected leaves show very few, if any, of these spots.

The cherry yellows is caused by a bud-transmittable virus. The yellowing and dropping of leaves is most pronounced in seasons when cool weather prevails just after the petals fall. Very early bloom in 1945 was followed by very low temperatures after the petal-fall and yellows symptoms were unusually severe. When high temperatures follow bloom, many infected trees show little or no yellow leaf and the presence of the disease can be definitely identified only by budding young peach trees from the suspected tree. Both the yellows virus and the ring-spot virus of cherry cause distinct reactions when budded into peach so the trees may be indexed in this way. There is no definite evidence whether the yellows virus is spreading in the orchard or not. Work on this problem is under way. Severely infected trees develop few lateral buds, and the willowy type of growth which results may be noted when yellow leaves are not present. A mosaic pattern of light and dark green may appear on a few leaves of yellows-infected trees from late July until October. The only method now known to prevent this disease in new plantings is to bud nursery stock from inspected stock and to rogue carefully all trees showing the disease in the nursery. This program has been under way for several years in New York nurseries and considerable progress has been made. The past season when symptoms were strongly expressed was a great help to this program.

It is important that the grower should be able to identify the true fungous leaf-spot, since it is controlled by spraying while the virus yellows is not. The fungus that causes the leaf-spot has a life history much like that of the apple-scab fungus. The leaf-spot fungus overwinters on the fallen leaves, and its fruiting bodies usually mature during the blossoming period before the cherry leaves have reached the susceptible stage. The fungus enters the leaf through the stomates, or breathing pores, in the lower side of the leaf. The stomates are not open until after the cherry leaf unfolds, which usually is after the petals fall. In both 1945 and 1946, however, some leaves reached the susceptible stage during a long cool bloom period before all the petals had fallen, and there was some leaf infection in both seasons before the petals were off. It is evident that the first spray for leaf-spot control should be applied promptly when most of the petals are falling.

Ascospore discharge is rapid during rains at a temperature of 61° F. and higher, but much less rapid at 54° F., and very sparse at from 39° to 46° F. Ascospore infection from a single rain is light, rarely averaging one lesion a leaf. This light primary infection is frequently overlooked but is highly important since heavy secondary infection may follow. Infection may be severe within only 4 hours of wetting at the most favorable temperatures.

Control

Turning under the fallen leaves greatly reduces the number of spores shot by the fungus in the spring rains. It is not possible, however, to control the leaf-spot fungus by this means, since not all of the leaves are destroyed even by the most careful work. Ground sprays have also been tested, but the same limitations exist as when used for apple scab (page 23). Dependence must be placed on a protective coating of a material that will prevent

the spores from germinating and growing into the green tissue.

Both sulfur and copper sprays have been used. Lime-sulfur and flotation sulfur paste are the common forms of sulfur used. Low-soluble copper sprays are more generally used because superior control of leaf-spot is obtained without dwarfing the fruit. Bordeaux mixture at 1½–6–100 or a combination of 1½–3–100 bordeaux mixture with 3 pounds of elemental sulfur to 100 gallons of spray may also be used, but the danger of foliage injury and dwarfing of the fruit should be considered before using this highly effective fungicide. Dwarfing of the fruit also has consistently followed lime-sulfur applications. During a four-year test, higher yields were obtained with low soluble copper and with sulfur paste than with lime-sulfur or bordeaux mixture.

Stem-end injury to Montmorency fruit in the form of a black ring appeared in appreciable amounts in a few orchards receiving low-soluble copper sprays in one year (1945) of the 13 years fixed coppers have been in general use. Leaf-spot control by the low-soluble copper compounds is superior to the control by sulfur sprays.

Two organic fungicides that have demonstrated their value as substitutes for low-soluble copper in the shuck and first fruit-fly sprays to prevent fruit injury are glyodin (2 heptadecylglyoxalidine) and ferbam (ferric dimethyldithiocarbamate). Captan also shows promise but has not yet been tested adequately in New York State.

Glyodin at 1½ pints per 100 gallons has given excellent control of leaf spot for the past five years and in only one year (1953) was the sugar content of the cherries below those receiving the fixed-copper sprays. Ferbam has also been more effective than the fixed coppers in a protectant schedule against leaf spot. There was a lower sugar content of the fruit with ferbam than with copper but this is apparently due to a delay in maturity. Deferring the harvest of ferbam-sprayed cherries seems to eliminate this difficulty. While glyodin and ferbam are good protectants neither possess much eradicant effect on leaf spots already present. The low-soluble coppers are effective as eradicants as well as protectants and are more effective than the organics when faulty timing of the protectant sprays has permitted primary infection to occur.

Both the 341B and the ferbam prevent the danger of black ring in the fruit caused by copper in the shuck and first fruit-fly sprays, but neither organic prevents arsenical injury to the fruit pedicels, known as *dry stem*, which in some years is followed by fruit shriveling and dropping on English Morello cherries and less frequently on the Montmorency variety. Ferbam should not be used on English Morello cherries because it is incompatible with the lime needed to reduce the danger of arsenical dry stem.

After a number of years of slight loss, dry stem was severe and destructive in 1950 on English Morello cherries in western New York, particularly in Wayne County, where the injury averaged about 40 per cent and reached a maximum of 90 per cent.

A few Montmorency orchards also suffered commercial loss from dry stem in 1950. The most severe losses were in orchards that received ferbam and no lime. The least injury was in orchards that received elemental-sulfur sprays throughout the season or in July for brown-rot control. Dry stem was first noted in serious amounts in 1925 when it was attributed to arsenical sprays. Experiments conducted by W. O. Gloyer at Geneva[8] definitely showed that the pedicel injury and the fruit dwarfing were caused by lead arsenate alone or in combination with bordeaux mixture, lime-sulfur, or elemental-sulfur sprays and dusts. The least injury was noted with the sulfur fungicides. Unpublished data in experi-

[8]Gloyer, W. O. The dwarfing, shriveling and dropping of cherries and prunes. New York (Geneva) Agr. Exp. Sta. Bull. 240:18; 4 Pl. 1926.

ments conducted in Orange County on the control of arsenical wood injury to peaches showed more corrective value with sulfur than with ferbam as against arsenical injury to the peach wood. Sulfur is ineffective as a seasonal schedule on Morello cherries in years when cherry leaf-spot is a problem. The addition of one or more elemental sulfur sprays in the summer on Morello appears to be the most promising means now known to reduce arsenical dry-stem and to afford some insurance against brown rot as well. Hydrated lime should be added to all sprays containing lead arsenate.

The fungicidal program consists in a prompt petal-fall spray, a second application when the shucks fall, and two later sprays timed primarily for the control of the cherry fruit flies. In some seasons when adequate control has not been obtained by these four sprays, an additional spray of low-soluble copper may be required in July. If there is any leaf-spot in the orchard at picking time, apply a spray immediately after harvest. Bordeaux mixture 1½–6–100 is the cheapest effective spray for this purpose after the fruits are picked.

The method of application in all leaf-spot sprays is most important. Cover the lower surfaces of the leaves with the spray to prevent leaf infection. Best control is obtained with sprays applied from the ground. Where this is not practicable, be as close to the ground as possible to direct the spray upward to the lower leaf surfaces.

Good control of leaf spot of sour cherries may be obtained by air-blast machines with both dilute and concentrate sprays. So far no dust program has been found to equal spray in cherry leaf-spot control in a year when the disease is severe.

PLUM CURCULIO

(Conotrachelus nenuphar Herbst)

(See also under *Peach,* page 73)

The plum curculio is present in most cherry orchards and is especially troublesome near stone walls or other hibernating shelter. The larva of the plum curculio is rather thick-set, is curved, and has a distinct head.

The beetles usually begin to attack the fruit shortly after the petals have fallen, and lay most of their eggs during the following two weeks. Unlike most of the other fruits attacked by the curculio, infested cherries usually remain on the tree until picking time.

Control

Sprays containing 2½ pounds of lead arsenate are effective against the plum curculio in the majority of western New York orchards. When you use lead arsenate on cherries, add 2½ pounds of hydrated spray lime to each 100 gallons of spray mixture to reduce arsenical injury. Reduce the dosage of lead arsenate to 1 pound in 100 gallons of spray on English Morello to lessen "dry stem" or arsenical injury.

Some early protection is afforded by the petal-fall spray, but the most important application of lead arsenate is the one made when the shucks are falling from the growing fruits. For better protection against curculio use in place of lead arsenate the control measures discussed under peaches (page 74).

You may include elemental sulfur in both of these applications for the control of leaf-spot and brown rot.

JAPANESE BEETLE

(Popillia japonica Newman)

(See also under *Peach,* page 76)

Japanese beetles where numerous sometimes remove half the foliage surface from sweet-cherry trees in July and August. The control measures suggested for Peach may be applied (page 76).

PEACH

In New York the peach suffers severely from **leaf-curl, brown rot,** and **scab** and, in certain localities, from the ravages of the **plum curculio.** The **oriental fruit moth** and **peach tree borers** have been major pests of peach and require suitable control measures. **Tarnished plant bug, European fruit lecanium,** and **cottony peach scale** are also important in some areas.

SPRAY OUTLINE

Leaf-curl spray

(After the leaves drop in the fall or in the spring before the buds swell)

Lime-sulfur* ..... 6½ gallons
or
DNC paste ..... ½ gallon
or
DNC dry wettable ..... 2 pounds
or
Ferbam ..... 1½ pounds
Water to make ..... 100 gallons

*If San José scale is present, 11 gallons of lime-sulfur should be used.

Bordeaux mixture may be used at 10–10–100 in the fall or 6–6–100 in the spring (page 71). Injury to peach buds has been reported from a late spring spray of 1 gallon of paste DNC (Elgetol).

The DNP materials (DN–289 and Elgetol 318) are not safe on peaches.

Pre-blossom spray

(When the blossoms show pink or a little earlier if a rain period threatens)

Lime-sulfur ..... 2 gallons
Water to make ..... 100 gallons
or
Elemental sulfur at manufacturers' directions
Water to make ..... 100 gallons
or
Captan ..... 2 pounds
Water to make ..... 100 gallons

This application is made to prevent **brown-rot blossom blight.**

If a dust schedule is followed, an application of dusting sulfur is indicated.

Where **tarnished plant bugs** (which "cat-face" the fruit) are a severe problem 2 pounds of DDT (50 per cent wettable powder) should be included. DDT should *not* be applied during bloom.

SUMMER SPRAYS

Two basic schedules may be followed to control peach insects. Most growers have replaced lead arsenate with one of these schedules because of the serious injury frequently caused by lead-arsenate sprays. Schedule 1 involves the use of the phosphate materials, EPN or parathion, plus fungicide. It is designed to control all of the major pests of peach and a number of minor pests with the exception of the Japanese beetle. The number of sprays given here have been carefully determined by experimental workers at the Geneva station and represent the minimum number of sprays for a complete peach insect and disease control schedule. Schedule 2 (page 70) is offered as second choice for those growers who prefer to use other than phosphate materials. Home orchardists are advised against the use of parathion or EPN.

Schedule 1

The following formula should be used in all sprays with the exception of the second fruit-moth spray.

EPN ..... 1¼ pounds
Elemental sulfur at manufacturers' directions
or
Parathion ..... 2 pounds
Elemental sulfur at manufacturers' directions
Water to make ..... 100 gallons

First curculio or shuck split spray

(When the first shucks are starting to split from the fruits that are going to set)

This spray is important for the control of **brown rot** and **plum curculio.** It also gives partial control of **tarnished plant bugs** where a problem.

The influence of temperature on effective control of the plum curculio is of great importance. Adults are active beginning at shuck split and for a period of 3 to 5 weeks thereafter, depending on area and the number of warm temperature periods. When temperatures of 70° to 75° F. are reached on 2 to 3 successive days, curculio adults become active. If such temperatures are reached just prior to shuck split, then injury can be expected immediately after the fruits are exposed. In such an instance the wise growers is early with his insecticide rather than late. If there is a week of hot weather after shuck split, a 7-day interval is advised, especially where parathion is used. EPN has somewhat longer residual action than parathion and a longer interval appears to be permissible.

Dieldrin may be used in the curculio sprays at the rate of ½ pound of the 50 per cent powder. It does not protect against the oriental fruit moth and borers, however, and the overall program is materially weakened. Since it is more effective than EPN, parathion, or methoxychlor for the control of plum curculio, some growers with a severe curculio problem and low populations of borers or fruit moth might find it of advantage.

Second curculio spray

(From 7 to 10 days after shuck-split spray)

The second spray is important for **plum curculio** and **brown rot** as well as for **first-brood oriental fruit moth** and the **lesser peach tree borer.** Spray the trunks and scaffold limbs as well as the fruit and foliage.

Third curculio spray

(From 7 to 10 days after second curculio spray)

A third spray is necessary in eastern New York to continue protection against the **plum curculio.** It is also of value against **brown rot, oriental fruit moth,** and **lesser peach tree borer.**

First fruit-moth spray

(From July 7 to July 15)

This first fruit-moth spray provides protection against **oriental fruit moth, peach tree borers, cottony peach scale, European fruit lecanium scale,** and **brown rot.** The spray is applied to trunks and scaffold limbs as well as to the foliage and fruit for maximum results, and is directed to the undersides of the leaves where scale insects are a problem.

Where **cottony peach scale** or **lecanium scale** is a problem, you may have to adjust the time of application for maximum control. Parathion or EPN is effective for a period from about 10 days after the beginning of the summer hatch of the crawlers of either scale until completion of the hatch. Where both scales are a problem, a spray at the completion of the cottony peach scale hatch will normally give protection against both species.

Second fruit-moth spray

(From August 1 to August 10)

The second fruit-moth spray is important for **oriental fruit moth** and **peach tree borers.** Sprays applied at this time should have low enough residues to constitute no problem on varieties such as Golden Jubilee and those picked later than Jubilee.

Special sprays

A final treatment of elemental sulfur alone at manufacturers' directions should be made just before harvest.

Japanese beetle

As parathion or EPN lose their toxicity to the Japanese beetle within 3 to 5 days, special measures must be taken in areas where the beetle is a problem.

In the southern part of the Hudson Valley where **Japanese beetle** infestations are heavy, fruit may require protection from mid-July to mid-August. Zinc dimethyldithiocarbamate (Ziram), 1½ pounds in 100 gallons of water, is a good repellent to Japanese beetle and may be substituted in place of the sulfur. If beetles attack the ripening fruit, make a preharvest rotenone spray or dust or a spray of Ziram. Further details are given in Cornell Extension Bulletin 770, *The Japanese Beetle*, available from the Mailing Room, New York State College of Agriculture, at Cornell University, Ithaca, New York.

Schedule 2

Schedule 2 involves the use of methoxychlor at the rate of 3 pounds in 100 gallons of spray in place of parathion or EPN in the curculio sprays. It protects against **plum curculio** and to some extent **tarnished plant bugs.** Apply DDT to the foliage and fruit to control the **oriental fruit moth** at the rate of 2 pounds in 100 gallons in two applications, the first about July 1 to 10, the second about July 14 to 24, followed by a third application of 1 pound of 50 per cent powder in an August 1 to August 10 spray. For control of **peach tree borer** the trunks and scaffold branches must be sprayed thoroughly with DDT at the rate of 3 pounds (50 per cent wettable powder) in 100 gallons. Two applications are made, beginning July 10 to 15 and followed in 21 days by a second treatment. Sulfur should be included in these sprays to control brown rot.

Control of the **lesser peach tree borer, cottony peach scale,** and **European fruit lecanium** is not possible with this summer schedule without using phosphate materials. For **scale insects,** a less effective alternative is available in the form of a dormant oil spray, using a 3 per cent concentration of a superior type dormant oil. **Japanese beetle** will be adequately controlled in areas where it is a problem by the DDT program suggested for oriental fruit moth control. If **brown rot** is the only problem, sulfur sprays or dusts may be used, making the first application 2 or 3 weeks after the shucks have fallen, the second from 2 to 4 weeks before the fruit ripens, and a final application just before harvest.

DESCRIPTION OF DISEASES AND INSECTS

PEACH LEAF-CURL

(Caused by the fungus *Exoascus deformans* (Berkley) Fuckel)

The leaf-curl of peach has long been known by commercial growers as an injurious disease. The disease is most common and destructive in the western New York fruit belt along Lake Ontario. Even there it is not serious every year, but in wet seasons it causes immense damage to unsprayed orchards.

The loss caused to peach growers by leaf-curl results from the dropping of leaves in the spring. This loss of leaves lowers the vitality of the trees, may cause a partial or a total failure of the trees to set a crop of fruit, and causes the trees to be more more susceptible to winterkilling. Loss of leaves for several consecutive seasons will kill trees outright. Young nursery stock may be killed or made worthless as a result of leaf-curl.

The disease is first recognized by a reddening and an arching of the young leaves as they begin to appear. Later these leaves become thickened and curled or crinkled, and have a yellowish color and a silvery sheen. These diseased leaves die and drop off in June, and the tree replaces them with a new growth of healthy

leaves. Young shoots of the current season's growth may become infected. Swellings develop on these affected twigs and they turn light green or yellow. The flowers and the young fruits also are often attacked, but usually these soon drop off and are unnoticed by the grower.

Spore-bearing sacks (asci) are formed by the peach-leaf-curl fungus in the spring just under the surface of the curled leaves. Before the diseased leaves dry up and drop to the ground, these sacks ripen their ascospores and discharge them immediately. These ascospores remain lodged on the twigs and upon the scales of the dormant buds through the summer and following winter. The ascospores sprout and form spores of another kind, known as *sprout conidia*, whenever the trees are wet with rain for any extended period. These sprout conidia will remain alive for more than a year.

When the buds swell in the spring, the ascorpores, or sprout conidia, are washed to the opening leaf buds by the spring rains. There the spores germinate and enter the tender leaf tissue which is exposed, if conditions of moisture and temperature are favorable. As the infected leaves develop they soon show the typical symptoms of leaf curl and the asci of the curl fungus develop and discharge a new crop of ascospores within a few weeks from the time of the infection.

Control

The control of peach leaf-curl is much simpler than the control of other common fungous diseases of fruit. For example, in the control of apple scab there is no practical way to destroy the overwintering form of the fungus. The curl fungus, however, overwinters in the form of spores on the bud scales and the twigs. One thorough application of 6½ gallons of lime-sulfur in 100 gallons of the spray mixture, applied at any time during the dormant period, controls peach leaf-curl.

Lime-sulfur is an effective spray material for the control of leaf curl in either fall or spring. The dinitros are effective at the rate of 2 quarts of the paste or 2 pounds of the dry DNC in either spring or in fall. The new DN–289 and Elgetol 318 (DNBP) are unsafe on peaches. The regular sodium dinitro cresol paste has killed some peach buds when used at a rate of 1 gallon to 100 gallons in spring sprays and in one unexplained instance 2 quarts to 100 gallons caused severe bud-killing in a New York peach orchard in 1949.

Bordeaux mixture, which appeared effective in many past tests, was ineffective when applied in the fall of 1946 to trees that were severely attacked the previous spring. Bordeaux gave some degree of control when applied in the spring but was less effective than lime-sulfur or dinitro materials applied in the spring or fall.

In more recent trials, bordeaux mixture has given excellent leaf-curl control at the rate of 10–10–100 in the fall and 6–6–100 in the spring. Ferbam has been found to be very effective against leaf curl at 1½ pounds per 100 gallons of spray applied either in the spring or in the fall.

There is a growing tendency among commercial peach growers to apply this spray in the fall. Delaying the spray until spring is dangerous, since the ground in the orchard is often too soft to permit spraying until after the buds have started to swell. If there is a rain period after the buds have started in the spring, severe leaf-curl is likely to result unless the spores have been destroyed by a spray. Most failures to control leaf-curl are caused by not applying the spray before the buds swell. Many failures to control leaf-curl result also when the work is not done thoroughly. Be sure to hit every bud with the spray, and follow out the terminals to the tips, to insure perfect control. Never apply the spray during freezing weather because of the danger of injury.

The question of spray injury by fall sprays with lime-sulfur is raised by a re-

port of such injury at St. Catherine's Canada, by Willison.[4] The injury occurred on weak, slender twigs formed late the previous season. The author states the injury was at the leaf scars where the tree did not form the normal protective layer after the leaves dropped. The rarity of its occurrence indicates lime-sulfur will not penetrate and injure a normal leaf scar. There was no injury from fall sprays the previous ten years at St. Catherine's but it was reported from Vineland, Canada, in 1927. Apparently the author does not conclude fall sprays should be discontinued since it rarely occurs and is serious only upon weak twigs.

Regardless of whether the buds have swelled before it was possible to spray in the spring, apply a leaf-curl spray. This spray does not affect curl infections that have already occurred but prevents further infections in later rains. If the buds are too advanced to risk the strong dormant materials, make an application of 2 gallons of lime-sulfur to each 100 gallons of spray or a heavy dosage of a good elemental sulfur, such as flotation sulfur paste, will be of value. In several years considerable reduction of curl by such a spray has resulted, and in some experiments commercial control of leaf-curl has been obtained.

BROWN ROT

(Caused by the fungus *Monilinia fructicola* (Winter) Honey)

Brown rot is the most common and most destructive disease of peaches and is also a serious disease of plum and cherry in this State. In some areas in which stone fruits are grown, more than one fungus is involved; in this State only *Monilinia fructicola* seems to be of commercial importance. This fungus has until recently been called *Sclerotinia fructigena.*

The fungus overwinters in this area in three ways. Brown-rot-infected fruits that have dropped to the ground and become partially buried in the soil develop tan-colored vase-like fruiting bodies measuring from ¼ to ½ inch across. These "vases" may have practically no stem or may be borne on stems several inches in length. When a clump of these vases or apothecia are uncovered in the grass beneath a peach or plum tree, a puff of smoke is often seen arising from them. This smoke consists of millions of the microscopic spores. The apothecia ripen and shoot these spores at about the same time the trees are in bloom. The spores drift to the trees and, if wet periods are long enough, the spores germinate and enter the open or unopened blossoms. In a short time an infected blossom wilts and becomes covered with the gray tufts of brown-rot summer spores, or conidia. The fungus continues to grow through the blossom stem into the fruit spur and may form a canker on the branch bearing the fruit spur. Later conidia develop on these cankers and are washed to the fruit during rain periods, and serious fruit rot may follow. Usually the number of blossoms blighted on peach is not in itself serious, but the cankers that result furnish large numbers of conidia. If rainy weather prevails as the fruit are maturing, severe fruit rot may follow even light blossom blight. The apothecia develop most abundantly on the half-buried mummies the second year after they drop to the ground and develop in decreasing numbers for several years more.

The brown-rot mummied fruits that are permitted to hang in the tree until spring become covered with brown-rot conidia that may cause blossom blight and and later fruit-rot.

The brown-rot fungus may overwinter in infected fruit spurs and in cankers. Conidia will develop on them also. Usually the fungus lives over in the cankers for no more than one year.

[4]Willison, R. S. Fall spray injury to peach trees. Sci. Agr. 19:670–672. 1939.

Control

Cultivation just before bloom to destroy the apothecia on the half-buried mummies is a valuable control measure. Merely disturbing the mummies causes the apothecia to shrivel. In addition, control of brown rot depends on both sanitation and a spray or dust program. Certain of the Southern States have demonstrated the importance of sanitation measures. Orchards in which satisfactory control of brown rot was not being obtained have eliminated brown rot as a serious problem after four years of strict practices of sanitation in addition to spraying. Boys are hired to pick all rotten fruits during harvest, and pickers are trained not to drop fruits with rot to the ground. Later, men are sent through the orchards to cut off all twigs bearing mummied fruits and to put them in bags, take them out of the orchards, and burn them. Growers who have practiced these strict measures of sanitation in addition to the regular spray program now report much less trouble with brown rot even on their most susceptible varieties.

The spray or dust program for brown-rot control consists of (1) an application as the blossom buds separate in the cluster and show pink, or a little earlier if a rain period threatens; (2) an application as the shucks fall from the young fruits that are going to stick; (3) an application three weeks later; (4) an application from two to three weeks before harvest; and (5) a final application just before harvest. This final application is an addition to the regular schedule suggested by recent experimental work in Niagara County which indicated a sulfur application was needed in 1945 close to harvest and that two or three dust applications were needed before all the fruits were adequately covered. No fungicide has, to date been shown to be superior to sulfur for brown-rot control. Pickers may object to this late dust program because sulfur irritates the eyes.

Brown-rot control is made easier if you follow cultural and fertilizer practices that produce firmer fruit. The control of such insects as plum curculio, capsids, and oriental fruit moth also are important in the control of brown rot.

PERENNIAL CANKERS

(Caused by the fungi *Valsa cincta* and *Valsa leucostoma)*

A high proportion of the perennial cankers of peaches in the State are started by immaturity-type winter injury. The winter-injured tissues are usually invaded by one of the two species of Valsa which increases the injury and prevents healing. Valsa cankers may also follow injuries caused by such insects as the oriental fruit moth and various borers. In addition, mechanical injuries and pruning wounds may be invaded by one of the Valsa fungi. Brown-rot cankers also serve as invasion points for the Valsa species.

Prevention

The prevention of winter injury which occurs when peach trees enter the winter in a tender immature condition is of greatest value. Stop cultivation and start a cover crop by mid-June. Do not use manure as a fertilizer, and apply no fertilizers after early spring. A second preventive measure is to delay the pruning of peach trees as late in the dormant period as possible. These wounds heal quickly in the spring and many cankers are prevented.

If the winter injury is on the trunk or main limbs of the tree, cut out canker margins and scrape out the discolored tissue, preferably in early May. A good combined wound dressing and disinfectant may be prepared by mixing 5 tablespoonfuls of Elgetol with 1 gallon of water-asphalt emulsion. This may be applied immediately after removing the canker.

PLUM CURCULIO

(Conotrachelus nenuphar Herbst)

The plum curculio is a serious pest of

peaches in New York. It is most abundant in orchards adjoining woods, hedgerows, and other protected situations which offer shelter for the overwintering beetles.

The adult plum curculio is an inconspicuous, grayish-brown, snouted beetle. In the spring, as fruit trees are in bloom, these insects begin to emerge from hibernation and invade the trees. Here they feed on leaves and blossoms until the small fruits appear. Egg-laying begins as soon as the developing fruits are exposed by the dropping of the shuck. Injury to fruit results from both feeding and egg-laying. A small crescent-shaped scar is made by the females at the time of egg laying and this characteristic injury serves as an easy means of identifying the work of the pest.

Both feeding and egg-laying scars result in russeted areas on the surface of the fruit and severely injured fruits become misshapen. Egg laying is chiefly during the three or four weeks following the setting of fruit. The activity of this pest is closely related to temperature; 75° F. is highly favorable, with activity decreasing at lower temperatures. Below 60° F. activity is negligible. The eggs hatch in about a week and the worms bore to the center of the fruit where they feed for several weeks before reaching maturity. The mature worms or larvae have a distinct head, the body is yellow in color, thick set, and curved in a U shape. Worms of this species do not readily crawl away when disturbed as do some others found in peaches. Except for cherry, most fruits containing larvae drop from the tree before harvest. The mature larvae leave the dropped fruits and enter the soil to a depth of several inches where they construct earthen cells. During a period of several weeks in the soil, larvae transform to pupae, then beetles. The beetles of the new brood emerge from the soil during August and feed on fruits until low temperatures in the fall force them into hibernation. In New York there is but a single generation, eggs being produced only by overwintering females.

Control

The plum curculio can be controlled by spraying with 2 pounds of parathion, or 3 pounds of methoxychlor, or 1¼ pounds of EPN, in 100 gallons of spray. Begin the applications when the shucks begin to fall. One or more sprays should follow at about 8-day intervals. In eastern New York a total of three sprays will be required in most years, while in western New York sufficient protection should be afforded by two sprays.

In the past growers have been dependent upon lead arsenate (2 pounds) and hydrated lime (16 pounds) to protect against plum curculio. Make one or two applications depending on the severity of the infestation. Some growers have substituted zinc-lime for the 16 pounds of hydrated lime, using 8 pounds of crystals, 7 pounds of flakes, or 5 pounds of monohydrated powdered zinc in addition to 8 pounds of lime. Most growers have replaced lead arsenate with one of the more effective organic compounds to control plum curculio. Two applications or more of lead arsenate can cause serious injury and even one application may be injurious.

PEACH SCAB

(Caused by the fungus *Cladosporium carpophilum* Thümen)

Peach scab, known also as *freckles* and *black spot*, is injurious wherever peaches are grown in New York. The damage is not realized by many growers who regard the disease as a necessary evil or mistake it for a peculiarity of the effected variety. There is no decay of the fruit, but its market value is lowered. The size is reduced and the fruit may crack. Diseased fruits often drop prematurely, and those that are picked do not ship well. Attacks are most general on late varieties.

Small, round, olive-black spots appear on infected fruits about six weeks after the petals have fallen. Usually, these lesions are on the upper side of the fruit.

When they are abundant, the fruit may crack.

Affected twigs show nearly circular yellowish brown blotches with a dark gray or a bluish border. When these are abundant, the cambium is killed and the twigs die.

Leaves also are attacked. Brown, scattered spots develop midway between the main veins, in which the tissue dries up and finally falls away, leaving circular holes.

The fungus overwinters in the twigs, and infections usually occur four or five weeks after the petals have fallen.

Control

If the regular spray schedule is followed, particularly in early summer, peach scab can be easily controlled.

ORIENTAL FRUIT MOTH

(Grapholitha molesta Busck.)

The oriental fruit moth has become a general pest of peaches since its appearance in New York about 1926. When first introduced, the pest caused heavy losses which threatened the peach industry. In recent years the pest has been less severe, possibly due to the activity of parasites and predators. The pest passes the winter as full-grown larvae in coccons in crevices on the trees or in debris near the trees. In the spring, the first moths appear shortly after bloom and begin to deposit their eggs on the foliage. The moths emerge over an extended period, and there are two or more broods a year in New York. The larvae of the first brood attack the tips of growing shoots, entering near the tips and burrowing down for a depth of several inches. Twigs attacked in this manner die and turn brown. The injured terminals offer conspicuous evidence of the insects' presence and activity. The larvae of later broods attack fruit as well as twigs. The small larvae frequently enter the fruit at the point of attachment of the stem, leaving no external evidence of their presence. Consequently, worm-infested fruit sometimes reaches the market despite careful sorting by the grower.

Control

Control of the oriental fruit moth is accomplished by use of either a phosphate program (parathion or EPN) or DDT. In the phosphate program, sprays timed for the plum curculio effectively reduce the twig-feeding activity of the first brood. By reducing the number of worms early in the season in this way two more sprays generally complete the program, one in early July and another in early August when subsequent broods are beginning their activity. In orchards where it is not desirable to use phosphates, three sprays of DDT are required. The first two sprays are applied at 10-day intervals in early July at the initiation of second brood activity using 50 per cent DDT powder at the rate of 2 pounds in 100 gallons of spray. The last spray is applied during early August at the initiation of third-brood activity, using 1 pound of DDT in 100 gallons of spray to reduce harvest residues.

PEACH TREE BORER

(Sanninoidea exitiosa (Say))

The adult peach tree borers are clear winged moths that fly during the day. The female is steel blue in color, with an orange band on the abdomen. The wing spread is from 1 to 1½ inches. Emergence of moths begins about July 10 and continues through late August. The reddish-brown eggs are deposited singly or in small groups on the trunk of the tree. Each female is capable of laying from 200 to 600 or more eggs. The eggs hatch in about 2 weeks under average summer conditions. The larvae are white in color, with a brown head, and feed on the cambium, or growing tissue of the tree just beneath the bark. Some of the larvae require two years to complete development but in most instances there is

but one brood a year. The larvae attack the trunk at ground level and, because of this habit, may cause serious losses. Injury to young trees may be particularly severe.

Control

Control measures in commercial orchards can be based on spraying with 3 pounds of 50 per cent DDT wettable powder in 100 gallons of spray. Two or three applications should be made beginning about July 7 to 12 and following at 3-week intervals. In some seasons a third application is not necessary. Because of the higher dosage necessary to control this pest, make separate applications for the borer. Thoroughly cover the trunks and scaffold limbs with spray. If a third application is made be careful not to spray the fruit as residues might be excessive.

Parathion may be used in place of DDT at the rate of 2 pounds of 15 per cent powder in 100 gallons of spray and has now largely replaced DDT. Two sprays are applied, one in early July and one in early August.

LESSER PEACH TREE BORER

Synanthedon pictipes (G. and R.)

The lesser peach tree borer is similar in many respects to the peach tree borer. The chief difference is in area of the tree attacked and duration of moth flight. The lesser species attacks injured areas on the trunk or branches, while the peach tree borer confines its attack to the trunk at soil level. Moths of the lesser peach tree borer are in flight from early June until September, reaching a peak in mid-July. There is a single generation each year in New York. The steel-blue, clear-winged moths deposit their eggs on the margins of wounded areas on the bark surface. The newly hatched larvae invade these wounds and cause them to become progressively larger. Larvae are unable to establish themselves on uninjured bark.

Control

Because of the habit of feeding almost exclusively in injured areas, prevent as much injury as possible. Be careful in fertilization practices to reduce winter injury to a minimum. Parathion may be used as a combined control measure for the lesser peach tree borer and the peach tree borer at the rate of 2 pounds of 15 per cent wettable powder in 100 gallons of spray. Make the applications as for peach tree borer, and in addition use either parathion or EPN in the curculio sprays. Programs using other than these two phosphate materials are ineffective against the lesser borer.

JAPANESE BEETLE

(Popillia japonica Newman)

The Japanese beetle has become established on Long Island, in the Hudson Valley, and in many of the larger cities and towns over the State. It can injure both by skeletonizing the foliage and by eating holes in the ripening fruit. The beetle is stout-bodied, about ½ inch long, and has a shiny green body with reddish bronze wing covers and a row of white dots around the hind parts. During the summer, the adult beetles deposit their eggs chiefly in short-grass sod in lawns and pastures. The resulting grubs, which are white with tan-colored heads, remain underground feeding on grass roots until the following summer. Beginning in June they transform into beetles. There is only one generation a year.

Control

Control measures are discussed on page 70.

COTTONY PEACH SCALE

(Pulvinaria amygdali Ckll.)

The cottony peach scale has appeared in outbreaks in western New York peach orchards from time to time. These epidemics have been less frequent since the general

use of phosphate insecticides to control peach pests. The cottony peach scale passes the winter on the branches as a partially grown scale. The overwintering forms grow rapidly in the spring. Just after the petals have fallen from the blossoms the snow white ovisac becomes visible beneath the body of the female scale. When scales are numerous, the white ovisacs resemble popcorn and are quite conspicuous on the branches. The appearance of the white ovisacs indicates the development of eggs, each female producing from 3000 to 6000. Hatching begins in mid- to late June and extends over a period of approximately three weeks. The newly hatched "crawlers" move from the egg mass to the leaves where they attach themselves and begin feeding by sucking plant juices. Injury to the fruit takes the form of black smutting, the result of fungus growth on the honeydew secreted by the pest. The actual feeding of the scale apparently causes no serious injury to the tree. The scales continue feeding on the leaves until fall when they migrate to the wood and attach themselves for the winter.

A program using either parathion or EPN in one spray is effective against the "crawlers." In practice, the early July spray for other peach insects is adjusted so as to fall within the last ten to fourteen days of crawler hatch. Where it is not desirable to use phophates, apply dormant superior oil at a 3 per cent concentration in the dormant period.

PLUM AND PRUNE

THE main troubles for which commercial growers of plums and prunes find spraying necessary are **plum curculio, leaf spot,** and **brown rot.** In some plantings, **European red mite, European fruit lecanium, apple maggot,** and **black knot** may require special attention.

SPRAY OUTLINE

SPRING SPRAYS

Green-tip spray

(As the buds are breaking)

Bordeaux mixture 6–12–100
Water to make ..... 100 gallons

or

Lime-sulfur ..... 11 gallons
Water to make ..... 100 gallons

If **black knot** is a serious problem, a green-tip spray should be made in addition to the regular shuck and summer sprays on plums and prunes. For the green-tip spray, both bordeaux and lime-sulfur have given good results.

If **bud moth** is a problem, 1 pint of nicotine sulfate or 1 pound of 15 per cent parathion should be included in the bordeaux formula above.

Pre-blossom spray

(Just before the blossoms open)

Lime-sulfur ..... 2 gallons
Water to make ..... 100 gallons

or

Elemental-sulfur paste .. 10 pounds
Oil type sticker ..... 1 pint
Water to make ..... 100 gallons

or

Captan ..... 2 pounds
Water to make ..... 100 gallons

This pre-blossom spray controls **brown-rot blossom-blight.**

First curculio spray

(When the shucks first start to split)

Elemental sulfur at manufacturers' directions
Parathion ..... 2 pounds
Water to make ..... 100 gallons

or

Elemental sulfur at manufacturers' directions
Methoxychlor ..... 3 pounds
Water to make ..... 100 gallons

The first formula is effective in checking **plum curculio, leaf spot, brown rot,** and **European red mites.** The second formula is of value for **plum curculio, leaf spot,** and **brown rot.** The remarks regarding temperatures given under the first curculio spray on peaches (page 69) also apply here. In orchards where curculio is a severe problem, dieldrin may be substituted for parathion or methoxychlor on a trial basis at the rate of ½ pound of the 50 per cent powder.

Second curculio spray

(From 7 to 10 days after the first curculio spray)

The same choice of materials may be made as in the first curculio spray.

Third curculio spray

(From 7 to 10 days after the second curculio spray)

A third spray is necessary in eastern New York to control **plum curculio.**

In seasons of extended activity of plum curculio, the third curculio spray may be needed in western New York and a fourth spray may be necessary in eastern New York, using the same materials and timing. The local county agent or Spray Information Service letter give the details.

Where **lecanium scale** is a problem, a spray using the parathion formula should be applied from sixteen to twenty days after the second curculio spray. In other words, at the completion of scale hatch. The undersides of the leaves must be thoroughly covered.

Later sprays

(Two or three weeks before the fruit ripens)

Elemental sulfur at manufacturers' directions
Water to make ..... 100 gallons

The applications control **brown rot** and **leaf spot.**

For a dust schedule, applications of dusting sulfur are indicated.

In some orchards, the **red-banded leaf roller** builds up in sufficient numbers to require control measures, Where parathion or EPN is used in the curculio spray, the first brood will be adequately controlled. Where methoxychlor or dieldrin is used, 1 pound of 50 per cent DDD powder should be added in the second curculio spray. For second brood control, DDD is used at the rate of 2 pounds of powder during the first week in August. Where DDT is being used for apple maggot control, the DDD may be substituted for DDT. Parathion at the rate of 1½ pounds of the 15 per cent powder is another effective material for the control of leaf roller and also for orchard mites and bud moth.

If **red mite** or **two-spotted mite** become a problem, tetraethyl pyrophosphate may be used at manufacturers' directions or parathion at 1 pound of 15 per cent powder or EPN at ½ pound in 100 gallons. Two applications from 7 to 10 days apart are necessary.

In some orchards, the **apple maggot** causes considerable damage to prunes. In orchards not surrounded or bordered by unsprayed trees, the maggot may be controlled with three to four applications of DDT. Applications of DDT, 2 pounds of 50 per cent wettable powder in 100 gallons of water, should be started about June 20 in eastern New York and about July 1 in western New York and applied at 10-day intervals.

DESCRIPTION OF DISEASES AND INSECTS

EUROPEAN FRUIT LECANIUM

(Lecanium corni Bouché)

At intervals of several years, the European fruit lecanium, a large, brown, soft-bodied, scale insect, appears in injurious numbers more or less locally in New York plum orchards. It occasionally attacks quinces also.

The mature female scales are about ⅛ inch in length and resemble a small halved pea, colored brown.

Badly infested trees are weakened and lose their foliage, and the fruit remains undersized or falls prematurely. The young scales produce a clear, sweetish liquid known as *honeydew*, which collects on the leaves and the fruit and serves as a medium for the growth of a fungus that smuts the fruit.

Control

You can control the lecanium scale by spraying the trees while dormant with a 2 per cent concentration of one of the "superior" dormant-type oils. Commercial oil emulsions may be used at the manufacturers' directions. A more satisfactory control measure is to use summer applications of either parathion, TEPP, or summer-oil emulsion. Use parathion at ½ pound, or TEPP at ¼ to ½ pint, or summer oil at 1 gallon, in 100 gallons of spray. Make two sprays, one at 50 per cent hatch and one at 100 per cent hatch, with parathion or TEPP. One spray at completion of hatch is enough if summer oil or 1 pound of parathion is used. Do not make summer-oil applications within 2 weeks of a DDT spray or within a month of a sulfur spray, as severe foliage and tree injury may result. For aid in timing summer sprays, consult the local Extension Service spray-information letters or your county agent.

EUROPEAN RED MITE

(Paratetranychus pilosus Canestrini & Fanzago)

(See also under *Apple*, page 34)

European red mites sometimes cause considerable injury to plums and prunes. When numerous they cause a bronzing of the leaves, which results in a dwarfing of the fruit and a reduction in shoot growth and fruit-bud formation.

Control

The red mite may be controlled on prunes by a green-tip or delayed-dormant spray of a 2 per cent "superior" dormant-type oil spray. If you use DDT in the summer sprays to control apple maggot, this dormant-oil treatment is often of value.

If you omit the dormant oil application and the mite appears in threatening numbers in the summer, they may be controlled by spraying with one of the summer acaricides discussed under red mite (page 35).

PLUM CURCULIO

(Conotrachelus nenuphar Herbst)

(See also under *Peach*, page 73)

The plum curculio is the most serious insect pest that attacks plums and prunes in New York. This insect is most abundant and destructive in orchards adjoining stone walls, hedgerows, and other protected situations, which offer shelter for the overwintering beetles.

Control

In the past, growers have depended largely on 2½ pounds of lead arsenate in 100 gallons of spray mixture. To reduce arsenical injury, use 16 pounds of hydrated spray lime with the arsenical. Follow the same considerations in regard to use of spray limes as discussed under peaches (page 74). Most growers, however, now use the more effective and less injurious organic compounds.

APPLE MAGGOT

(Rhagoletis pomonella Walsh)

(See also under *Apple*, page 43)

Although the apple maggot is seldom a problem in large commercial prune-growing areas, it does cause concern in some of the smaller plantings, particularly those where the orchards are surrounded by unsprayed prune, apple, and other fruit trees. Unless these trees can be sprayed or cut down it is difficult to obtain complete protection against the apple maggot by spraying. The maggot flies may feed in the unsprayed trees and migrate to the sprayed trees where many of them will deposit eggs in the fruits before they are killed by the sprays that have been applied.

Control

In orchards not surrounded or bordered by unsprayed trees, the maggot may be controlled by three to five applications of a DDT spray. Use a DDT wettable powder at the rate of 2 pounds of actual DDT in 100 gallons of water. Apply the first spray about June 20, and the remaining sprays at intervals of ten days in the Hudson Valley and begin about July 1 in western New York.

JAPANESE BEETLE

(Popillia japonica Newman)

(See also under *Peach*, page 70)

The Japanese beetle tends to feed much more heavily on plum and prune foliage than on peach.

Control

Control can be obtained with sprays of DDT at 2 pounds of 50 per cent wettable powder in 100 gallons of water applied at 2-week intervals starting in the first or second week of July.

BROWN ROT

(Caused by the fungus *Monilinia fructicola* (Winter) Honey)

(See also *Peach*, page 72)

The brown rot of stone fruits is a serious disease on plums and prunes in New York. The life history of the fungus causing this disease is given on page 72.

Control

The regular spray schedule adequately controls brown rot without additional consideration.

BLACK KNOT

(Caused by the fungus *Plowrightia morbosa* (Schweinitz) Saccardo)

Black knot is a serious disease of plum and prune. It occurs on wild and cultivated forms of both plum and cherry, but is much commoner on plum.

The disease affects only the woody parts. It is confined usually to the twigs, but is found occasionally on the larger limbs and the trunk. The knots vary from ½ inch to 1 foot or more in length, and from a fraction of an inch to 2 inches in circumference. The knots usually do not completely surround the limb. In the spring the young knots are olive-green in color, and are firm but rather pulpy. Later the knots turn black and become hard and brittle.

The olive-green knots are the points from which the spores of the fungus are spread. During April, May, and June, some of these spores lodge on other trees, germinate, and grow into the bark and the growing tissue. The irritation causes the tree to develop a large amount of bark tissue, which appears in the fall as a slight swelling. In the spring the new knot enlarges and splits open, and the fungus soon forms its spores giving the knot a velvety-green appearance.

Control

Black knot may be remedied by pruning out the knots during the winter or before growth starts in the spring. Make the cut about 4 inches below the base of the visible swelling. Give the orchard a second inspection during the latter part of May, to remove knots that are not visible in the winter but which would swell rapidly in the spring and produce spores that would spread the disease. Be sure to burn all pruned knots. Remove carefully any knots developed on large limbs or trunks for about ½ inch beyond the boundary of the knots. It is not necessary to remove much wood, even beneath the visibly knotted area. Prune or remove all plums, prunes, and cherries in the near vicinity, both cultivated and wild.

Where black knot is a serious problem, apply a delayed-dormant spray about the time the buds are breaking, in addition to the regular shuck and summer sprays on plums and prunes. For the delayed-dormant spray, liquid lime-sulfur diluted 1–8 with water or a 6–12–100 bordeaux-oil-emulsion spray containing 3 per cent of oil has given good results. The oil in the mixture is also effective against red mites.

PLUM LEAF-SPOT

(Caused by the fungus *Coccomyces prunophorae* Higgins)

Plum leaf-spot is caused by a fungus that is similar to the cherry leaf-spot fungus in its life history (page 64) but matures slightly later in the spring. The leaf-spots on plum are similar in appearance to those on cherry, but the shot-hole effect is much commoner. The effect of heavy leaf infection is much more serious on the current season's plum crop than on the cherry crop, because a heavy fruit-drop often follows the leaf infection.

Control

The spray schedule for the control of plum leaf-spot consists in a spray containing elemental sulfur or 2–4–100 bordeaux mixture when the shucks are falling and two summer sprays of elemental sulfur, the first two or three weeks after the shuck spray and the second two or three weeks before the fruit is picked. Make both sprays before rain periods. Russeting of the fruit may follow the use of the bordeaux mixture in the shuck spray. The Stanley variety appears to be much more susceptible to this copper injury than is the Fellenberg prune.

RED-BANDED LEAF ROLLER

(*Argyrotaenia velutinana* Walker)

Occasionally the red-banded leaf roller becomes a serious pest of commercial plums and prunes, particularly in the western New York area. The life history is probably the same is it is on apples as reported on page 32, but further studies are needed.

Control

Although special tests have not been conducted on prunes, it is felt that the program as outlined for apples should also be effective on prunes. Parathion or EPN if used for curculio control will effectively control the first brood. If other materials are used for curculio, DDD at the rate of 1 pound of the 50 per cent powder in 100 gallons of spray applied ten days after the shuck split should be reasonably effective.

For control of the second brood, DDD at the rate of 2 pounds of 50 per cent powder, or parathion at the rate of 1½ pounds of the 15 per cent powder, in 100 gallons of spray applied during the first week of August should be effective. The DDT could replace DDT in the apple-maggot program for this spray and the parathion could be used where mites are threatening.

QUINCE

FORTUNATELY, the quince is subject to attack by only a comparatively small number of insects and diseases. In the past the most serious insect enemy has been the **quince curculio,** but the **oriental fruit-moth** is now much more destructive. The **red-banded leaf roller** has also caused considerable losses in recent years. Among diseases subject to control by spraying, the most important is **leaf-blight** and **fruit spot;** occasionally the **Brooks fruit spot** may cause serious losses.

SPRAYING OUTLINE

SPRING SPRAYS

Dormant spray

(In the spring before the buds start)

Dormant-type oil emulsion, diluted to contain 3 per cent of oil.

Apply this when **lecanium scale** becomes abundant, or for **European red mite.** Summer measures as discussed under peaches and prunes may be used if this spray is omitted.

Pink spray

(When the blossoms show pink)

Lime-sulfur ..... 2½ gallons
Water to make ..... 100 gallons
or
3–8–100 bordeaux mixture
or
Ferbam ..... 1½ pounds
or
Elemental sulfur (actual sulfur) ..... 5 pounds

The lime-sulfur gives good control but often causes considerable spray injury. Bordeaux mixture gives excellent control of **leaf-blight** and **fruit spot** but fruit and leaf injury may be severe. Ferbam gives good disease control and sulfur gives fair control. Neither causes spray injury at this time.

Petal-fall spray

(When 90 per cent of the petals have started to wither)

Bordeaux mixture 3–8–100
or
Ferbam ..... 1½ pounds
or
Elemental sulfur (actual sulfur) ..... 5 pounds
DDT ..... 2 pounds
Water to make ..... 100 gallons

This spray controls **leaf-blight, leaf spot, codling moth,** and **oriental fruit moth.**

If **plum curculio** is a problem, 2 pounds of lead arsenate may be added to the formula.

Lime-sulfur should not be used with DDT. When lead arsenate and lime-sulfur are used, 1 pound of lime is added for each pound of lead arsenate.

LATER SPRAYS

The same formula as suggested in the petal-fall spray is advised except that sulfur is not suggested after the petal-fall spray.

The first application is made ten days after the petal-fall spray. This spray controls **leaf spot, leaf-blight,** and **oriental fruit moth.** If **quince curculio** is a problem, 3 pounds of lead arsenate is added to the formula.

Two applications after the petal-fall spray are usually enough to control **leaf spot, leaf-blight,** and **quince curculio.**

For the control of **oriental fruit moth** with DDT, from three to four more ap-

plications should follow the 10-day spray at 19- to 21-day intervals.

DDD (TDE) may be used in place of DDT during the first two weeks in August at the rate of 2 pounds of 50 per cent powder in 100 gallons of spray to control **red-banded leaf roller.** The DDD should provide enough protection against **oriental fruit moth** without the addition of DDT.

DESCRIPTION OF DISEASES AND INSECTS

QUINCE LEAF-BLIGHT AND FRUIT-SPOT

(Caused by the fungus *Fabraea maculata* (Leville) Atkinson)

Quince leaf-blight is prevalent on quinces in New York, and occurs also on pears. On quinces the disease is called *leaf-blight, black-spot, fruit-spot,* and *scald.* Defoliation is common in nurseries and may occur on mature trees. As a result, the quince fruits remain small and subsequent crops are reduced. In light infestations, scattered spots are found on the fruit; in severe attacks, the fruits are badly spotted and become cracked and deformed.

The disease first appears on the upper surface of the quince leaf as circular, discolored spots with a reddish center and a dull border. Later the spots extend through the leaf, showing on the under surface, and the black fruiting bodies of the fungus appear in the center of the spots as conspicuous black dots. The spots are usually about ⅛ inch across but they may coalesce into extended brown areas. The appearance on the twig is similar to that on the leaf. The twig may be completely circled by the spot and may die as a result.

On the fruit the disease appears as circular blackish spots with a red or a white margin and a black dot at the center. The spots are somewhat sunken and may be as much as ¼ inch in diameter. When numerous they coalesce into deep brown or blackish areas, over which are scattered the block dots, or fruiting bodies, of the fungus (figure 21).

The fungus causing this trouble overwinters in the dead leaves in much the same way as does the apple-scab fungus. The fruiting bodies in these fallen leaves are usually ripe and ready to shoot out their ascospores by the blossoming time of the quince. The ascospores are discharged during wet weather and are carried by air currents up into the trees.

The spores that lodge on tender leaf tissue germinate and grow into the leaf, and about a week later the spots begin to appear. Later the summer spores are borne in the black fruiting bodies already mentioned, in the center of each spot. These spores are spread and start new infections during wet periods. The spots appear on the quince fruits when these have reached nearly mature size.

Further studies on this fungus are needed, but it appears probable that the spores from the quince attack also pear, apple, hawthorn, and other closely related plants.

Control

Quince leaf-blight and fruit spot may be controlled by a number of fungicides applied at pink, petal fall, ten days later, and twenty days later. Lime-sulfur at 2½ gallons per 100 gallons gives good control but causes considerable spray injury. Bordeaux mixture 3–8–100 gives excellent control but severe fruit and leaf injury may result. Ferbam gives good disease control and causes no injury but is considerably more expensive than the other fungicides. Elemental sulfur gives fair disease control and causes no spray injury. If you use DDT as an insecticide, do not use lime-sulfur. The use of sulfur after

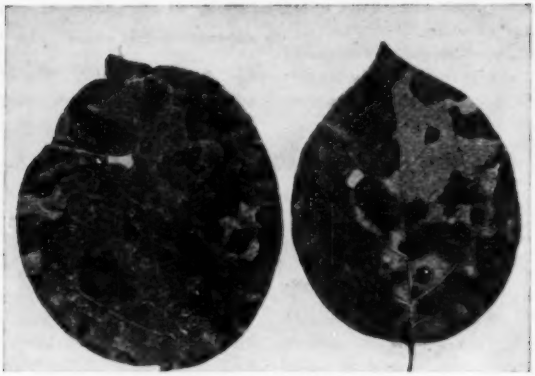


FIGURE 21. QUINCE LEAF-BLIGHT

the petal fall spray is not suggested. Three-years experimental results indicate 3–8–100 bordeaux mixture should replace the 6–16–100 formula previously used.

QUINCE CURCULIO

(Conotrachelus crataegi Walsh)

Many knotty quinces in eastern New York are the result of attack by a brownish gray, broad-shouldered, snout beetle, about ¼ inch in length, known as the *quince curculio*. In western New York these beetles usually appear on the trees in late June or July; the date varies from year to year owing to weather and the condition of the soil in which grubs have passed the winter. In feeding, the curculio cuts a small hole in the skin of the fruit with its jaws at the tip of its snout, and then eats out a cavity in the pulp. The beetle deposits its eggs in similar cavities. The larvae, or grubs, burrow through the flesh. They become full-grown in about a month, and, leaving the fruit, fall to the ground. There at a depth of 2 or 3 inches, they form an earthen cell where they pass the winter in the larval stage. Pupation does not take place until the following spring.

Control

One can control the quince curculio by making two applications of lead arsenate, 3 pounds in 100 gallons of the spray mixture. The first spray is applied when the beetles appear on the trees, and the second about a week later. DDT does not control this insect.

ORIENTAL FRUIT MOTH

(Grapholitha molesta Busck)

(See also under *Peach*, page 75)

The oriental fruit moth is a serious pest of quinces. The larvae of all broods attack the fruit directly, and twig injury seldom occurs on the quince. The eggs are usually deposited on the upper surface of the leaves and may also be found on the calyx lobes.

Control

DDT is the most effective way to control this pest on quinces. Use a DDT wettable powder at a rate to make 2 pounds in each 100 gallons of spray mixture. Five or six applications are necessary at 19- to 21-day intervals.

EUROPEAN FRUIT LECANIUM

(Lecanium corni Bouché)

(See also under *Plum and Prune*, page 79)

The quince is sometimes seriously infested with the same lecanium scale that attacks plum. When it is abundant, a special spray for its control may be necessary, using the same material as is used for the insect on plum.

SPRAY MATERIALS

THE number of spray materials that can be used advantageously in the average commercial orchard under New York conditions is now more extensive than formerly. The most important of these are lime-sulfur, elemental sulfurs, ferbam, glyodin, captan, phenyl mercuries, lead arsenate, DDT, nicotine sulfate, parathion, and TEPP for general use, and bordeaux mixture, oil preparations, methoxychlor, DN compounds and DDD for special purposes.

The selection of the standard materials now generally used is not a matter of chance, but is based on results obtained by practical growers during many years of experience. That this choice is sound, in the main, has been proved time and again by the experimental tests conducted by the workers at experiment stations.

SULFUR SPRAYS

Lime-sulfur solution

For many years lime-sulfur was the most widely used fungicide and insecticide for orchard fruits because of its wide range of usefulness. It is still used at the higher concentrations to control peach leaf curl and to some extent against San José scale. Lime-sulfur has been largely replaced by oil sprays when San José scale is serious and for the control of pear psylla. At the summer strength of 1–50 it was formerly the chief spray for the control of apple scab and cherry leaf-spot. Now elemental sulfur and various organic fungicides have replaced lime-sulfur for apple-scab control in most of the best orchards, because lime-sulfur, though an effective fungicide, reduces photosynthesis, reduces blossom-bud formation, and decreases yields. Most of the better apple growers keep enough lime-sulfur or one of the mercurial fungicides on hand for an emergency spray if need for it arises. Low-soluble copper, elemental sulfur sprays and organic fungicides have replaced lime-sulfur as the fungicide for leaf-spot control in sour cherries because the low-soluble copper sprays and some of the organics give better control than does lime-sulfur and neither the low-soluble copper, the organic fungicides, nor the elemental-sulfur sprays dwarf the fruit as do both lime-sulfur and bordeaux mixture.

The low-soluble copper is itself being replaced to some extent on Montmorency sour cherries by glyodin and ferbam, principally to insure against stem-end injury to the fruit. Ferbam, however, is incompatible with lime needed to reduce arsenical injury (dry stem) and should not be used with lead arsenate on English Morello.

Lime-sulfur solution is prepared by boiling freshly burned high-grade calcium lime with sulfur and water. The commercial concentrate generally sold is a clear, orange-red solution that usually contains between 25 and 26 per cent of total dissolved sulfur and tests from 32° to 33° Baumé. While most commercial brands test approximately as indicated, there may be considerable variation, and the safest plan is to test each barrel with a hydrometer, preferably one marked with a Baumé scale. All recommendations in this bulletin as to the quantity of lime-sulfur to be used are based on a solution testing 32° Baumé. If solutions of other strengths are used, corrections should be made according to table 3.

It is possible to make concentrated lime-sulfur solution on the farm if one wishes to go to the trouble and the expense for equipment. Directions for preparing the homemade solution can be obtained from the state experiment stations.

Other sulfur sprays

Much confusion exists regarding the sulfur sprays in common use, because of the similarity of names and the variety of names often applied to the same mate-

TABLE 3. LIME-SULFUR DILUTION

Hydrometer reading in degrees Baumé	Gallons of lime-sulfur used in 100 gallons of spray			
32° (standard test)	11	6½	2½	2
20°	22¼	13	5	4
21°	20¾	12¼	4¾	3¾
22°	19½	11¼	4¼	3½
23°	18¼	10½	4	3¼
24°	17	10	3¾	3
25°	16	9¼	3½	3
26°	15	8¾	3½	2¾
27°	14¼	8¼	3¼	2¾
28°	13½	8	3	2½
29°	12¾	7½	2¾	2¼
30°	12¼	7¼	2¾	2¼
31°	11½	6¾	2½	2
32°	11	6½	2½	2
33°	10½	6¼	2¼	2
34°	10¼	6	2¼	1¾
35°	9¾	5¾	2¼	1¾

rial. *Lime-sulfur solution* refers to the liquid obtained by boiling lime, sulfur, and water. *Dry lime-sulfur* is a yellow, pungent powder obtained by evaporating lime-sulfur solution.

Elemental sulfur is the name applied to a number of spray materials that contain the element sulfur either in paste form or in a dry powder with the addition of a wetting agent so they are readily dispersible in water. Sulfur dusts all contain elemental sulfur.

The elemental sulfurs may be grouped according to the general method of manufacture.

1. Flotation sulfur paste is a by-product of illuminating-gas manufacture. Flotation paste is an extremely finely divided sulfur with the individual particles measuring only 1 or 2 microns in diameter. (A micron equals $^1/_{25\,400}$ of an inch.) Tests over a period of years have shown flotation paste to be more effective in apple-scab control than any of the dry wettable sulfurs. Two types of flotation sulfur paste are on the market. The thylox type contains a higher proportion of sulfur but is no more effective than an equal number of pounds of the ferrox type. A few brands of flotation sulfur have been manufactured with a high proportion of sulfur and a small amount of glue to make the paste flowable. Paste sulfurs containing glue are less effective in scab control than is the same paste without the glue. There have been a few instances of spray injury from improperly washed flotation sulfur in this State in the past. At present it is believed there are no flotation sulfur pastes being sold that contain more than 1 per cent of total soluble salts and most samples have less than 0.5 per cent.

2. One paste sulfur (Magnetic 70) is manufactured by a method of wet grinding. The sulfur particles are 5 microns or less in diameter and the paste contains 70 per cent of sulfur. This paste has appeared fully equal to flotation sulfur paste in all but one year's tests.

3. Micronized sulfur is a dry wettable sulfur manufactured by whirling sulfur and a wetting agent in a 300-mile-per-hour wind so that the particles are ground fine by collision or attrition. Micronized sulfur is very finely divided with most of the sulfur particles less than 4 microns in diameter.

A similar process has been developed which can produce as finely divided sulfur as micronized sulfur. Replicated field tests have shown that these other air-reduction products can be made fully as effective in scab control as micronized sulfur. Both processes are used for manufacturing dusts as well as sprays.

4. Another dry wettable sulfur (Dowmike), manufactured by a variant of the Grindrod process, produces spherical particles about 5 microns in diameter.

5. Dry ground sulfur, sold under many brand names, contains a wide range of particle sizes. Most of the dry ground sulfurs will pass through a silk screen with 325 meshes to the inch. The sulfur particles vary from 45 microns to less than 1 micron in diameter with most of the product in the 30- to 5-micron range. A few of the proprietary dry wettable sulfurs are even coarser.

These coarse sulfurs are inferior in scab

control during the early season when temperatures are low. It has been proved that sulfur kills scab spores by volatilizing and passing within the spore where the sulfur is converted to hydrogen sulfide which kills the spore. The amount of sulfur volatilizing from coarse sulfur is small in comparison with finely divided sulfur with much greater surface area. In the higher summer temperatures apparently enough sulfur is volatilized from the coarse sulfurs for adequate scab control.

Spray injury to leaves and fruit has also been shown to be caused by the sulfur vapor which enters the tissue and is there converted to hydrogen sulfide. If the hydrogen sulfide concentration is high enough, there will be fruit injury and at a somewhat higher temperature leaf injury. The reduction in sulfur sunscald of fruit which occurs when 325-mesh sulfurs are substituted for the more finely divided sulfurs is apparently due to a lesser volatilization of sulfur from the limited surface area of the coarse sulfur particles. In unusually hot weather for New York, as in 1952, there was severe injury with microfine sulfurs and some injury also with the 325-mesh materials. Injury from super-fine sulfurs in summer sprays has caused a strong distrust of sulfur at any time in the minds of some workers.

6. Bentonite sulfur produced by fusing sulfur with bentonite is hard to grade as to particle size under the microscope. The estimate of foremost authorities on sulfur is that the bulk of the sulfur particles are in or below the 1- to 2-micron class.

All figures on particle size are rough approximations. Individuals lots may vary greatly from these figures and the processes are constantly being changed or modified. There are wide differences in these materials aside from the particle size that affect their fungicidal value. The materials are listed in the order of their effectiveness in scab control in orchard tests.

BORDEAUX MIXTURE

Bordeaux mixture may be used on apples as an emulsifier for oil sprays prior to the delayed-dormant spray. It is used also to a limited extent in summer in combination with summer oil and in the spray immediately preceding applications of summer oils to prevent injury resulting from these oils with sulfur sprays or on trees carrying a sulfur residue. A 2–8–100 bordeaux mixture appears to be adequate for scab control in these summer sprays, and superior to the proprietary copper sprays in scab control.

The use on apples of any copper compound now known is attended with some danger of injury to foliage and fruit. The most dangerous period is from the delayed-dormant spray through the first cover spray. Any of the later sprays also may be injurious. Copper injury is most likely to occur during periods of cool wet weather, while in periods of extreme heat the injury may be much less than the results from sulfur applications.

In this State elemental sulfurs have caused serious spray injury to apple leaves as well as to fruit in only 3 years (1936, 1948, and 1951) in more than 25 years of extensive use on apples. Fruit injury is much more frequent, but much of the sulfur sun-scald may be prevented in most years by the use of 325-mesh sulfur in summer application and in delaying sulfur applications until after periods of intense heat. In some areas of the State there was serious fruit russeting following copper sprays almost every year when they were generally used. Bordeaux mixture was formerly much used to emulsify dormant-type spray oils but now the oils are emulsified with blood albumen and the bordeaux added for disease control.

Weak bordeaux (¾–6–100) appears to be effective in late-summer sprays in the reduction of arsenical injury.

A combination of bordeaux mixture with summer oil has been used for combined control of brown rot, leaf-spot, and

red mite on prunes. Severe russeting occurred in some orchards receiving this spray in 1946, especially on the Stanley variety.

A weak bordeaux mixture with a large amount of hydrated lime to reduce the danger of russeting the fruit is used as a fungicide on pears.

Preparation of mixture

Instant method of preparing bordeaux mixture

The instant method depends upon the use of finely powdered copper sulfate. This material should be as fine in texture as high-grade table salt. The chemical hydrated lime should be of such fineness that 98 per cent will pass through a 300-mesh sieve.

For each 100 gallons of 2–8–100 bordeaux mixture, (1) weigh out 2 pounds of powdered copper sulfate and 8 pounds hydrated lime; (2) fill the spray tank one-fourth full of water; (3) start the agitator; (4) add the powdered copper sulfate by washing it through the strainer or by sifting it in slowly; (5) add water until the tank is three-fourths full, with agitator running; (6) add the hydrated lime as a thin paste; (7) fill the tank and allow the engine to run at least a minute longer.

Vigorous agitation is essential. If agitation is poor, the mixture should be sprayed back into the tank.

Old method of preparing bordeaux mixure

Copper-sulfate crystals are used in the old method. Make a stock solution of copper sulfate (blue vitriol) by weighing 1 pound of the crystals for each gallon of water. Usually from 40 to 45 pounds of the copper-sulfate crystals are placed in a clean burlap sack and suspended in the top of a barrel containing as many gallons of water as there are pounds of vitriol. Even in cold water, the vitriol usually dissolves in five or six hours. Cover the barrel to prevent evaporation and to keep the solution clean. No iron should be allowed to come in contact with the solution.

Prepare a stock solution of lime in another barrel by stirring from 20 to 25 pounds of hydrated spray lime into an equal number of gallons of water.

Stir the stock solutions thoroughly before using them.

To prepare a 2–8–100 bordeaux mixture, fill the tank three-fourths full of water, start the agitator, and add 2 gallons of the copper sulfate stock solution for each 100 gallons of spray. After the copper sulfate has been well mixed with the water, add 8 gallons of the stock lime through the strainer for each 100 gallons of spray, with the agitator running. A sky-blue bordeaux mixture should result. Then fill the tank with water.

When bordeaux mixture is added to tank-mixed oil emulsions for scab control, add the copper sulfate when the tank is one-fourth full of water, agitate it, and add the lime when the tank is nearly full as described under the instant method.

LOW-SOLUBLE COPPER COMPOUNDS

A number of low-soluble copper compounds have been developed as substitutes for bordeaux mixture. In general, they are somewhat less effective than bordeaux mixture in disease control but cause considerably less spray injury to certain tree fruits. These compounds, containing basic chlorides and sulfates of copper, vary in content from 12 to 56 per cent of metallic copper. The low-soluble, or "fixed," coppers are used extensively on sour cherries for leaf-spot control. When used at a dosage of ¾ pound of metallic copper in each 100 gallons of spray, with the addition of 3 pounds of hydrated lime and 1 pint of an oil-type sticker, all of these compounds appear to give good leaf-spot control under New York State conditions without the dwarfing of the fruit caused

by bordeaux mixture. In 1945, for the only time during 14 years of quite general use, stem-end injury to Montmorency fruits in the form of a black ring appeared in serious amounts in a few orchards receiving low-soluble copper sprays. Apparently injury is most likely to occur from the shuck-fall and first fruit-fly sprays. Combination schedules in which the low-soluble coppers are replaced by organic compounds in these sprays are being tested. The low-soluble copper sprays may cause fruit russet on apples in this State especially if applied before midsummer.

ORGANIC FUNGICIDES

The best known and longest tested organic fungicide on fruit is ferbam (ferric dimethyldithiocarbamate). Ferbam is the most effective fungicide known for the control of the three rusts of red cedar that attack apple. Usually it is used in combination with elemental sulfur for the combined control of cedar rusts and apple scab. Ferbam at the rate of 1½ pounds in 100 gallons of spray is equal to dry wettable sulfur in scab control. (See also under *apple scab*, page 23). It is compatible with oil, but oil-ferbam mixtures may leave more or less black residue on the fruit. Used in the summer sprays on pears, ferbam controls sooty blotch and Fabraea leaf- and fruit-spot. On sour cherries, ferbam is about equal to the low-soluble coppers in leaf-spot control. Used with soluble cottonseed oil as a pre-harvest spray on red and on black sweet cherries, it controls brown rot and gives less visible residue than sulfur. Sulfur sprays are essential earlier for brown-rot control. Ferbam is ineffective as an arsenical corrective for peaches in dosages up to 1½ pounds in 100 gallons of spray.

Glyodin (2 heptadecyl glyoxalidine) is a newer effective protectant fungicide which is now being used extensively as a fungicide on apple (page 24) and on sour cherry (page 66).

Captan (4N trichloro tetra hydrophthalamide) is a still more recent addition to the organic fruit fungicides. It is already quite widely used on apple, particularly the Golden Delicious variety (page 25) and appears promising in the control of brown rot blossom blight of stone fruits.

A number of other organic protectant fungicides under trial on tree fruits have not yet been used enough to evaluate them properly.

Another group of organic fungicides that have been used quite extensively for after-infection control of apple scab are the phenyl mercuries. The lactate salt of these phenyl mercuries has been used longest in liquid form (Puratized Agricultural spray). The acetate salts are sold in liquid form as Puratized Apple Spray and as Tag Fungicide. An acetate salt is also available in powder form (Coromerc). These materials have been used most extensively against apple scab (page 24). A number of newer mercurials are now under test. A napthoquinone compound (Phygon) also possesses some effectiveness in after infection control of apple scab (page 24).

Neither the mercurials nor the naphthoquinone spray have been effective in destroying scab lesions already present on the foliage. For this purpose an insecticide, dinitro orthocresol sold in New York State as DN Dry Mix No. 2) has been found to be more effective and much cheaper (page 10).

LEAD ARSENATE

For many years, lead arsenate has been the standard arsenical used in the commercial orchards of New York. Lead arsenate can be used with lime-sulfur sprays as well as with most other standard fungicides and insecticides. Unfortunately, lead arsenate, when used in the later applications, is likely to leave objectionable lead, as well as arsenical residues, on the fruit. If used in these sprays, it should be applied with great care or some preparation should be made to remove excess residue by washing.

The present unofficial tolerances permitted on apples and pears are 0.025 grain of arsenic trioxide and 0.05 grain of lead for each pound of fruit. The tolerances on fruits other than apples and pears are 0.01 grain of arsenate trioxide and 0.025 grain of lead for each pound of fruit.

When employed in dusting orchard fruits, 20 per cent by weight of lead arsenate is used in combination with sulfur dust. It is usually advisable to add 20 per cent by weight of lime to the dust mixture to reduce arsenical injury, especially on peaches.

NICOTINE

For spraying, nicotine is sold usually in the form of nicotine sulfate. The standard brands of nicotine sulfate on the market contain 40 per cent of nicotine. Nicotine sulfate is not volatile, but the fumes of the nicotine are liberated when the material is applied as a spray in combination with lime, lime-sulfur, wettable sulfurs, or bordeaux mixture. If used in water alone, 1 pound of soap flakes, or 3 pounds of spray lime should be dissolved in each 100 gallons of the spray mixture.

SPREADERS AND STICKERS

A number of materials may be added to spray mixtures that will give more uniform coverage and better adhesion on the leaves and fruit. In mixing spray in the tank, it is usually advisable to add these spreaders before any other of the spray materials. The materials most commonly used for this purpose are: soap, skimmilk powder, soybean flour with lime, or commercially prepared stickers and spreaders.

Although soap is useful as a spreader and activator in combination with nicotine sulfate, it should not be used with arsenicals, DDT, or lime-sulfur. Either skimmilk powder or soybean flour with lime may be used with the common spray materials with one exception; soybean flour should not be used with nitrogen spray fertilizers containing urea (Nu-green, and the like) as injury may result. A number of satisfactory commercial stickers and spreaders are available for use on fruit. Generally they are more expensive than the materials listed here. They should be used according to the directions of the manufacturer.

Skimmilk powder and lime may be used in summer applications of lead arsenate for codling-moth control.

Many of the commercial wettable sulfur preparations and DDT wettable powders contain a spreader, and the use of an additional spreading agent may result in an undue run-off of the spray and reduce the adherence of the materials. A small amount of summer oil is sometimes used as a sticker. Its usefulness is limited because it should not be used with sulfur fungicides or DDT and it adds to the difficulty of spray-residue removal. Where stickers can be safely used, a good home-made type involves the use of ½ pound of soybean flour and 1 pint summer oil in 100 gallons of the spray mixture.

DDT

DDT (dichlorodiphenyltrichloroethane) has been tested intensively and found to be a valuable insecticide for the control of orchard insects. At present it is unquestionably the most effective way to control codling moth. It is also effective in controlling apple maggot, red bug, fruit tree leaf roller, tent caterpillars, oriental fruit moth, japanese beetle, plant bugs, leafhoppers, and numerous other pests.

There is some evidence that DDT may favor build-up of some formerly minor insects such as European red mite, two-spotted mite, red-banded leafroller, mealy bugs, and some aphid species by killing their natural parasites and predators.

DDT is compatible with most of the insecticides and fungicides commonly used on fruit. It should not be used with oil because this combination frequently causes severe injury to the foliage as well as to increase greatly the toxic residue on the

fruit at harvest time. Spray lime may be added to DDT sprays when lead arsenate or bordeaux mixture is used, but should not be added when DDT is used with other materials. Lime should not be included in DDT dusts because it greatly reduces the toxicity of the DDT within a few weeks.

Analysis of DDT spray residue on fruit sprayed experimentally indicate that four to five cover sprays of a wettable DDT powder can be made without exceeding the tentative tolerance established by the Food and Drug Administration. This tolerance permits 7 milligrams of DDT per kilogram of fruit, or 0.05 grain per pound of fruit. This tolerance is established for use only on apples and pears. No DDT spray should be applied within 14 days of harvest and a 21-day interval is preferable.

At present, it is suggested that only wettable DDT powders be used on fruit since little is yet known about the use of emulsions and other forms on fruit. If a dust is preferred, it should contain 5 per cent DDT and may be mixed with sulfur if desirable.

PETROLEUM OIL SPRAYS

Petroleum oil sprays are of considerable importance in the control of insects on fruit. Spray oils are divided into two groups depending upon the season in which they are used, namely: dormant-type oils and summer oils.

"Superior" dormant oils

Dormant-type petroleum oils are used to control lecanium scale, San José scale, scurfy scale, fruit tree leaf roller, red bug, European red mite, pear psylla, pear leaf blister mite, and cottony peach scale.

The concentrations of dormant-spray oil recommended in this bulletin for the control of oil-susceptible species of insects and mites are based on experience with oils of high paraffinic and relatively low aromatic content. Specifications for dormant tree-spray oils of this character were established at the New York State Agricultural Experiment Station, at Geneva, New York, in 1947 by P. J. Chapman and G. W. Pearce under the designation of "superior" type. This product has met with wide acceptance in New York and is gaining favor elsewhere. The current specifications are presented in table 4.

Oils that meet the above specifications have proved relatively safe on fruit trees after some growth has appeared, thus permitting their use in the green-tip to delayed-dormant stages of bud development. This practice has now become standard principally for two reasons: (1) petroleum oils are more efficient when used after growth has begun, and (2) the danger of injury from DN compounds and oil is

TABLE 4. SPECIFICATIONS OF SPRAY OILS FOR USE ON FRUIT TREES IN THE DORMANT AND SEMI-DORMANT PERIOD

Items*	Specification
Viscosity (Saybolt, at 100° F.)	90 to 120 seconds
Viscosity index (Kinematic)	90 (minimum)
Gravity (A.P.I. degrees)	31 (minimum)
Unsulfonated residue (A.S.T.M.)	90 (minimum)
Pour point	Not greater than 30° F.
Homogeneity	A relatively narrow boiling distillate portion of petroleum

*The following methods of testing spray oils are to be used: *Kinematic Viscosity,* A.S.T.M. Designation: D445–39T. *Conversion to Saybolt Universal Viscosity,* A.S.T.M. Designation: D446–39. *Kinematic Viscosity Index:* A.S.T.M. Designation: D567–40T. A.P.I. *Gravity:* A.S.T.M. Designation: D287–39. *Prou point:* A.S.T.M. Designation: D97–39. *Unsulfonated Residue:* A.S.T.M. Designation: D483–40.

reduced to a minimum when DN materials are used in the dormant stage and oils at a later stage.

Spray oils are generally "tank mixed"; therefore, amounts of oil to be used are based on gallons of raw oil in 100 gallons of spray mixture. Blood albumin is used as the emulsifier and the procedure employed is as follows: (1) with the spraying machine engine running, draw a small quantity (20–25 gallons in 300–400 gallon tank) of water into the tank, (2) next, add the emulsifier which is normally blood albumin used at the rate of 2 ounces of actual blood (8 ounces of the commercial product) in 100 gallons of spray, (3) add the oil, (4) open the spray gun that is directed into the spray tank for 1 to 2 minutes, (emulsification is effected through the circulation of oil, water, and emulsifier through the pump and out through the spray gun), (5) the concentrated emulsion formed in step 4 is now ready for dilution to spray strength. Clean the hose line of concentrated emulsion, preferably by returning it to the tank, before applying any of the mixture. When Bordeaux mixture is added to a tank-mix oil formulation, the copper sulfate is added after step 3 and the lime when the tank is almost full.

Dormant-type oils are marketed in two forms: (1) products in which the emulsifier is already present and (2) straight oil that must be emulsified in the spray tank before it can be used and often referred to as tank mixing. Of the first class there are the concentrated emulsions that contain from 66 to 83 per cent actual oil and resemble a thin white paste in appearance. Another class called *emulsible oils, soluble oils,* and *miscible oils* consist of oil and an oil-soluble emulsifier. They are not emulsions as sold, but produce emulsions when added to water.

The number of gallons of any commercial preparation to use in the spray tank can be figured by dividing the percentage of actual oil desired, by the percentage of oil present in the stock emulsion as stated on the label on the container. Example: If you use a stock emulsion labeled 66 per cent oil and want to get an emulsion in the spray tank containing 3 per cent actual oil, use 4½ gallons of oil to each 100 gallons of the spray mixture: $3.0 \div 0.66 = 4.5$ gallons.

While these stock emulsions are reasonably stable, some of the oil may separate out if they are allowed to freeze or are stored for considerable periods of time. If the stock emulsion shows any considerable amount of free oil and preliminary efforts show it will not emulsify properly, it is unsafe for use and should be discarded.

The early oils used by growers in New York State frequently caused severe injury which resulted in general disfavor with the use of dormant oils. Recent findings regarding the relationship between chemical composition and effectiveness have greatly extended the range of safety in the use of oils.

Listed below are some points that have not always been appreciated in making maximum use of dormant oils.

1. Dormant oils should be applied at temperatures above freezing.

2. In general, materials used in combination with oils penetrate more effectively and persist longer than when used alone. Thus, sulfur or dinitro materials would be more likely to cause injury when combined with oil.

3. Over-spraying in a single operation will not result in excessive oil deposit, but the deposit can be doubled if drying is permitted between applications. Thus "spraying with the wind" frequently results in overlapping and excessive oil deposit.

4. Oil emulsions of equal concentration but prepared with two different emulsifiers may vary in actual oil deposit as much as 100 per cent or more.

Summer oils

Summer oil, that is, highly refined mineral oil with a viscosity of 60 to 85 and an unsulfonatable residue of 90 or above has been used effectively in summer applications for mite control. Summer oils may be mixed with bordeaux mixture, insoluble copper, lead arsenate, nicotine sulfate, fixed nicotine, but they are not compatible with sulfur materials or DDT. Summer oils should not be used preceding or following sulfur sprays unless 21 days have elapsed between applications. Summer-oil sprays should not precede or follow DDT applications unless a 12- to 14-day interval has elapsed, and even then there is danger of injury and of excessive DDT residues at harvest time.

DORMANT DINITRO COMPOUNDS

Two types of DN compounds suitable for use in the dormant stage of bud development are available.

DNC compounds

DNC compounds are known to growers as Elgetol, Krenite, DN Dry Mix No. 2, and the like. They are available in both liquid and powder form. They contain approximately 20 per cent sodium or ammonium salts of dinitro ortho cresol in the liquid form and approximately 40 per cent dinitro ortho cresol in the powder form. The DNC liquid requires vigorous stirring in the original container to get the toxicant in solution. Some growers find it convenient to dilute to a "stock mixture" for ease of handling. The DNC powder can be used without the effort required to mix the liquid forms of DNC. Tests have shown, however, that the powder form is less effective on pear psylla eggs than the liquid form and there is some evidence to indicate that the powder forms are generally less effective under field conditions.

These compounds are used to control bud moth, oystershell scale, rosy apple aphid, black cherry aphid, and pear psylla, and are helpful in controlling apple aphid by killing the overwintering eggs on the trees.

For best results, DNC compounds should be applied on apples and cherries in the dormant period before the buds begin to show green. They are effective in killing aphid eggs, but not live aphids at the dosage recommended, thus the application should be made by spraying the tree in one complete operation and before the aphids start to hatch. If applied after green tissue is exposed, some burning will result. Since DNC compounds are frequently followed by sprays of dormant-type oil, they should be applied as early in the spring as possible. To avoid danger of oil-dinitro injury, a rain should occur between the application of dinitro and oil sprays to remove the dinitro compounds from the buds and branches. Although some growers have used oil-dinitro sprays without injury, trees have been injured by the use of this combination and it is not recommended.

Fall applications of DNC compounds are as effective as spring applications in controlling rosy aphid and eye-spotted bud moth. No evidence is yet available as to whether or not fall applications are as effective in controlling oystershell scale as are spring applications. Theoretically, there seems to be no reason why they should not be effective. If fall applications are made, they should not be applied until most of the leaves have fallen from the tree.

One of the liquid DNC compounds, *called Elgetol,* used at the rate of 2 quarts in 100 gallons of spray, is effective as a ground spray to destroy the over-wintering stage of the apple-scab fungus when applied in the spring in the dormant stage and through the green-tip stage at the rate of 500 to 600 gallons an acre. At this concentration the ground spray may be combined with the dormant tree spray for insect control in the spring. Elgetol also destroys the overwintering stage of pear scab, cherry leaf-spot, and possibly grape

black rot and the brown rot of stone fruits, when applied as a ground spray, but the value of ground sprays against these diseases has not been so thoroughly tested. Elgetol sprays are ineffective against brown rot in peach mummies remaining in the trees. A dormant spray of Elgetol at the rate of 2 quarts in 100 gallons of spray controls peach leaf curl. Bud injury to peaches has been reported with Elgetol when used at the rate of 1 gallon in 100 gallons of spray at the green-tip stage. Krenite and Dinitrosol are liquid DNC compounds containing the same toxicant as Elgetol but with different wetting agents, while DN Dry Wettable is a powder containing the same compound. The value of these products as ground sprays has not yet been determined.

DNBP compounds

DNBP compounds were introduced in 1949 and are known as DN–289 and Elgetol 318 and are available in liquid form only. They are true solutions and contain 36 per cent of the triethanol amine salt of dinitro secondary butyl phenol. DNBP materials cause injury when applied to many deciduous fruit trees after growth has begun; therefore, they must be *used in the strict dormant* with one exception. For the treatment of pear psylla eggs, the sprays may be delayed until the green-tip stage without causing serious injury. Danger of injury to peaches and quinces is so great that DNBP compounds are not recommended for use on these fruits at any time.

The DNBP compounds are recommended for control of aphids, bud moth, oystershell scale, San José scale, and pear-psylla eggs. They have been recommended for control of overwintering eggs of the European red mite, but experience has shown that mite populations build up more rapidly in the summer when DNBP materials are used than when petroleum oils are used. The dormant oil application is therefore preferable for this purpose.

PARATHION

Parathion is an organic phosphorous compound generally marketed in the form of a wettable powder containing 15 per cent of 0,0–diethyl 0–p–nitrophenyl thiophosphate the active toxicant. It is also available in dust form containing from ½ to 2 per cent toxicant. The value of dust applications in fruit insect control has not been fully evaluated although dusts have been used with success in the field. Parathion sprays are of value against a relatively wide range of insects and mites, including bud moth, aphids, European red mite, two-spotted mite, red-banded leaf roller, pear psylla, plum curculio, codling moth, oriental fruit moth, peach tree borer, lesser peach tree borer, peach cottony scale, and lecanium scale. Although toxic to apple-maggot flies, present evidence shows parathion to be ineffective when used in a standard spray schedule against this pest.

Parathion is compatible with other spray materials with the possible exception of lime-sulfur and dormant oil.

The use of parathion on McIntosh, Cortland, McCown, Kendall, and Milton, and other varieties related to McIntosh, involves risk of both foliage and fruit injury. Fruit injury can be entirely prevented by the use of activated charcoal at the rate of ¾ the amount of parathion used. Foliage injury up to twenty days after petal-fall cannot, however, be entirely eliminated in years favorable to injury, such as 1953, even with the charcoal added to the mixture. In the 1952 and 1953 seasons, considerable evidence was obtained pointing to a reduction in apple-scab control by fungicides through the use of this material. Orchards where excellent scab-control practices were followed were unaffected, but orchards where failure in timing resulted in scab infection showed substantial increases, where the parathion was used. In 1953 some evidence was obtained that this material may reduce the fruit set on a number of

varieties. The reason for this reduction is not fully known.

The wettable-powder form of this material can cause serious injury or death to humans if improperly handled. The widespread use of the material by growers shows conclusively that it can be used safely and it is adviseable to follow the precautions given on page 96 of this bulletin to insure continuous safe use. It is also suggested that thinning or suckering operations be postponed for at least two or three days after an application of this insecticide. Parathion may be used up to 14 days of harvest without danger of excessive residue.

TEPP

TEPP is an organic phosphate containing various percentages of tetraethyl pyrophosphate as the active toxicant. Products containing 40 per cent toxicant are the most common, although several products containing 20 per cent TEPP are available. It is also formulated as a dust; the 1 per cent concentration is most generally available. TEPP breaks down (hydrolyzes) rather rapidly when it comes in contact with water. For this reason, dusts should be especially formulated and packaged in tight containers to insure against loss of effectiveness. With present formulating methods it is adviseable to use a dust within two to three weeks of formulation.

TEPP is effective for summer control of orchard mites and aphids, peach cottony scale, and lecanium scale. It is compatible with most of the spray materials in use but should not be used with lime or bordeaux inasmuch as these alkaline materials cause it to deteriorate rapidly.

When TEPP was combined with the glyoxalidine material 341-C, injury to fruit during the 1950 and 1953 seasons was in the form of a brown ring. Necrotic spots were also produced where TEPP was used alone, especially in concentrate sprays. This material is highly toxic to humans and warm-blooded animals. Any TEPP spilled on the skin should be washed off immediately with soap and water. The precautions suggested on page 96 should be followed to insure safe use of this material. The toxic action of TEPP is principally as a contact poison, and decomposition takes place rather rapidly after the spray is applied resulting in harmless materials being formed.

METHOXYCHLOR

Methoxychlor is a chlorinated hydrocarbon (dimethoxydiphenyl trichloroethane) which is of value in controlling plum curculio on deciduous tree fruits. As indicated by the chemical name, it is related to DDT. Its compatibility is approximately the same as that for DDT and its toxicity to warm-blooded animals is low.

BHC AND LINDANE

BHC is a chlorinated hydrocarbon. It is composed of five known isomers of which the gamma isomer is largely responsible for its insecticidal action. The gamma isomer is available in two forms: (1) as crude benzene hexachloride, containing in the wettable powder form 6, 10, and 12 per cent gamma isomer plus other isomers and (2) as lindane which is the pure (98 per cent plus) gamma isomer and generally formulated as a 25 per cent wettable powder. They should not be used after the petal fall or shuck split spray on fruit. Compatability is of the same order as DDT.

DDD

DDD is a very close relative of DDT. It's compatability is of the same order as DDT. It is useful primarily to control redbanded leaf roller.

DIELDRIN

Dieldrin is a halogenated hydrocarbon which has proved to be highly effective against the plum curculio. It should not be used after the first cover spray because of the possibility of excessive harvest resi-

dues. Although not a phosphate, it is relatively poisonous to man and label precautions should be strictly adhered to.

ARAMITE

Aramite is formulated as a 15 per cent powder for use on fruit. It is a non-phosphate miticide. In Cornell experiments it has been effective in controlling the two-spotted mite but its control of European red mite has been somewhat variable. It is relatively safe to use and is compatible with most of the commonly used chemicals including lime.

DIMITE

Dimite is formulated as a 25 per cent liquid. It is of limited value against orchard mites. It offers little hazard to humans.

SULPHENONE

Sulphenone is formulated as a 50 per cent powder. It is of limited value against orchard mites. It offers little hazard to humans.

OVOTRAN

Ovotran is also known as Orthotran. It is formulated as a 50 per cent wettable powder. It offers little hazard to humans and may be used as a substitute for dormant oil against European red mites on apple.

EPN

EPN is an organic phosphate formulated as a 25 per cent wettable powder. It is dangerous to humans and must be used with precautions. It should not be used on McIntosh, and its relatives since neither foliage nor fruit injury can be corrected.

SAFETY WITH INSECTICIDES

THE organic phosphate materials, parathion, EPN, TEPP, and systox are highly poisonous to man if improperly used. Three deaths in the United States during 1949 resulted from careless handling of parathion. On the other hand, more than a billion gallons of parathion spray was applied without trouble. From studies made of these deaths, the following precautions have been suggested:

1. The greatest danger from parathion wettable powder appears to be in the operation of putting the wettable powder from the bag or can into the spray tank. Be careful at this point.
2. Wear a respirator with a filter for powders and an activated charcoal filter for organic vapors.
3. Wear natural rubber gloves.
4. Protect the body from wettable powder and from spray drift. Wear rubber or plastic coats or wash your clothes frequently.
5. Symptoms of poisoning: headache, nausea, pin-point vision, constriction of the chest.
6. If the above symptoms are experienced, do not delay—see your doctor. The antidote is atropine sulphate and cannot be obtained without a doctor's prescription.
7. Never thin and remove suckers until several days after parathion applications. Handling insecticides safely is similar to driving an automobile or, handling fire. If certain precautions are followed, these useful instruments and materials can be used to advantage. If misused, they can do serious harm.

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